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THE ROMANCE OF TRANSPORT

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THE ROMANCE OF TRANSPORT

BY

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PUBLISHER'S NOTE

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The Romance of Transport

CHAPTER I

BEASTS OF BURDEN

TRAVEL and transportation, which we define respectively as the moving of persons and of things, formed one of the earliest problems to engage the attention of man. He found it necessary to move from place to place, to follow game or to find fruits and edible roots. And later, when animals were domesticated, he had to move from one pasture to another with his flocks and herds. Then, again, there were constant movements of tribes, even in the earliest times In the Bible we learn of the migration of the family of Abraham, the Hebrews, who left Palestine for Egypt because of the famine in their own land.

Man's only means of travel in the earliest times—in the dawn of history, that is—was the two legs with which Nature has endowed him. To enable him to move about more rapidly various forms of protective footgear were introduced Local conditions had naturally an important bearing on the exact form of any particular device. The snowshoe, for instance, originated in snowy regions. In the extreme north, where the cold was intense, snowshoes with only a few coarse meshes were satisfactory. Farther south, however, where the snow was not so compact, the shoes had to be made larger and the mesh finer In Northern Europe and Asia the coarse-meshed snowshoe remains in use to-day, along with the Norwegian ski, while in Northern Canada and Alaska the fine-meshed snowshoe is more commonly to be seen. The

ski is used almost exclusively for purposes of pleasure (Plate II, *B*).

Primitive man was barefoot, just as natives in the tropics are to-day. The sandal, introduced in very early times, probably resulted from the use of small strips of hide cut to the shape of the foot and fastened to it with thongs. In some countries the hide was replaced by tough fibre, coarsely woven to form a covering for the foot. From this primitive form the varied footgear of the nations has evolved throughout the ages—the moccasin, gaiter, buskin, legging, and top-boot—all intended to make travel on foot easier.

Sandals were worn by the ancient Greeks and by the Roman plebeians, but the Roman patricians wore leather boots, which are frequently mentioned by Roman historians. In early times the Britons too probably wore sandals, which were later replaced by a kind of boot made of skins. Boots first became popular in England during the reign of Edward IV, when it was fashionable to wear them with such ridiculously long 'beaks' (or pointed toes) that they required supports. In the case of the wealthier classes these supports took the form of light silver chains fastened to the knees of the wearer; others used laces. During the reigns of Charles I and Charles II boots with bag-like open tops were fashionable. These were followed by the jackboot, and then by the Hessian and the Wellington boot. Shoes as at present worn were introduced about 1633.

With the development of the boot and the shoe other devices have been introduced to assist the traveller. These are both varied and numerous, and include the pilgrim's staff of medieval times, the staves used by coolies for innumerable purposes, and the modern equivalent—the alpenstock of the mountaineer. Then there are stilts, steps, and ladders, the inclined plane and the modern elevator, all of which play important parts in travel and transport.

When primitive man desired to carry a burden—food, fuel, or housing material, for instance—his shoulders, arms, or head

ıaturally called into service. In the earliest tim ractically no other way of transporting anythin nt of material that has been moved in this way ıs nceptıon. Until comparatively recent years the r ery mound, earthwork, and embankment, and f en and brick structure, were all carried and elev n muscles. In ancient times, when slave-lab

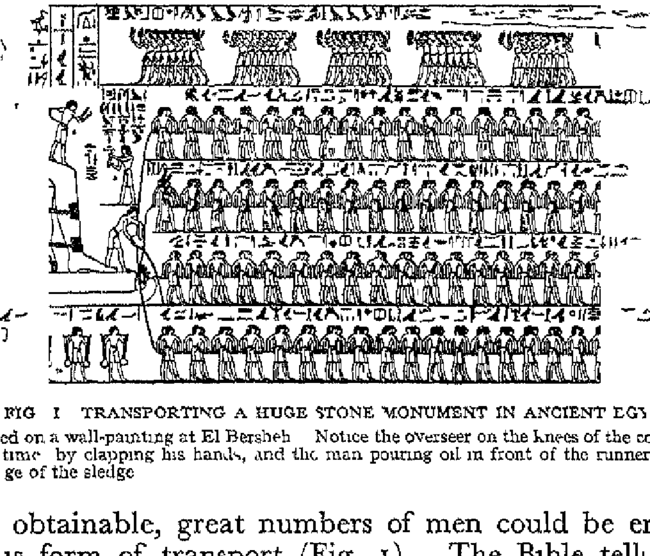


FIG I TRANSPORTING A HUGE STONE MONUMENT IN ANCIENT EGY
ed on a wall-painting at El Bersheh Notice the overseer on the knees of the co time by clapping his hands, and the man pouring oil in front of the runner ge of the sledge

obtainable, great numbers of men could be er ıs form of transport (Fig. 1) The Bible tell ce, that 70,000 men were used for the tran ial in the building of Solomon's Temple Incic er 80,000 men were employed in the mountain g wood for the beams and panelling. In the c of the Pyramids, according to Herodotus, 100,c employed for twenty years—some in building, c orting the necessary material Although undo form of primitive lifting device was used in these , much of the material was moved and lifted s

the human burden-bearer. Even to-day a primitive form of handling things has not been eliminated completely (Plate I, *A*, and II, *A*), we have only to look at a house in the course of construction to realize that every brick is carried to the brick-layer on a man's head or shoulders Then, again, most of the freight at the railway-stations and much of that on the quay-sides is lifted and borne again and again in the same way.

The human body has proved itself to be adaptable to the carrying of a great variety of burdens, and many devices have been introduced to facilitate transport in this way. The Eskimo mother carries her infant in the ample hood of her warm seal-skin robe. Farther south, where the temperature is warmer, young Red Indians are transported in papoose frames, in which they ride until their legs are strong enough to bear them. Similar contrivances are in use in other parts of the world (Plate I, *B*), and these are not always limited to transport of children (Plate I, *C*) There are many forms of baskets and other devices (such as hods for bricks and yokes for milk-pails) for carrying both solids and liquids in quantity, all of which have been introduced with the purpose of increasing the capacity of the human being for transport.

Man must have observed at an early date how the form of four-footed animals enables them to carry burdens with ease, and they have been used as beasts of burden from prehistoric times. Although thousands of years have passed since the time when animals were first used, practically the same animals are employed to-day for the same purposes In some cases they have been supplanted by more modern means of transport, but in others they cannot be excelled. The camel in sandy districts, for example, or the mule on tortuous mountain-paths, has no rival—unless it be the aeroplane, and even that modern contribution to the problem of transport has its limitations.

The camel (Plate III, *A*) has been used for transport in the East from very early times—certainly from the Sumerian civilization of 6000 B.C., if not earlier. There are two species,

the common camel of Arabia (*Camelus dromedarius*), with one hump, and the Bactrian camel (*Camelus bactrianus*), with two humps, which is found in Asia, Tibet, and China Of these the former is by far the more valuable, and is superior in every respect. The dromedary is a lighter breed of camel, chiefly used for riding, whereas the camel is more generally employed as a beast of burden

Because of its special development (in the form of honeycomb cells of the reticulum), the camel can store sufficient water in its system to last out the distance between the oases in the desert where water is obtainable from wells. An experienced Arabian camel, having been allowed to drink as much water as required before starting on its journey, can exist for five or even six days without drinking again.[1] It has also the ability to go on for a comparatively long time without food, and thus is particularly useful for desert transport.

The feet of the camel are well adapted for walking on dry sand, the broad toes being furnished with soft, wide cushions that present a considerable surface to the loose sand. The camel has constantly to kneel to be loaded or unloaded, and its knees are provided with thick pads, which support its weight without injuring the skin The nostrils are valve-like and immediately close if they encounter the slightest trace of drifting sand. The hump is a curious structure and of great importance in judging the condition of the beast. It contains a store of nourishment on which the camel 'feeds' as it crosses the desert, the hump gradually diminishing, so that at the end of a long journey it nearly disappears

A camel will carry a load of 600 pounds comfortably, and although the Arab will never overload his camel, in India and other countries into which this animal has been introduced, the same consideration has not always been shown At one time hundreds of camels were sacrificed every year by owners

[1] The Bactrian camel is not so enduring, however, and requires a fresh supply of water every three days

who were indifferent to the suffering or condition of their charges.

The camel's rate of travel is not as great as is generally supposed, and even the pace of a comparatively swift-travelling animal, the Heirie, has been exaggerated. The number of strides per minute has been counted to average 38, the length of stride varying from 6 feet 6 inches to 7 feet 6 inches. An average of these gives three miles an hour, and this is probably the highest speed that lightly loaded camels can keep up on a journey. The speed of the Heirie does not exceed a maximum of eight or ten miles an hour, but such a high speed could only be maintained for an hour or so without a halt. The sweet temper of the camel is as imaginary as its speed.

In hot countries the mule (Plate III, *C*) is even more serviceable than the horse, for it can get along on less food. The mule (a cross-breed between the horse and the ass) is believed to have been bred first in Mysia, an ancient province of Asia Minor Homer tells of the Mysians' giving mules to Priam for his chariot. He also mentions that mules were employed to transport heavy timber beams. The mule is often referred to in the Bible, but no mention of it is made before the time of David, when the Israelites were becoming accustomed to the use of horses. The mule was used by the Greeks and the Romans both as a beast of burden and for drawing carts. To-day mules are used in all parts of the world, and during the last century were in use in London and elsewhere for drawing the trams. Considerable numbers of them were employed during the War for all kinds of transport, both as pack and as draught animals.

The ass and the donkey—the most despised of animals—have long been in use in the East both for riding and for the carriage of goods (Plate III, *B*). Probably originating in the Somali ass, the ass had reached as far as Syria and Arabia even in prehistoric times. It was much used by the ancients of the Orient as a beast of burden and—along with

the ox—played an important part in everyday life. Even to the Egyptians, Hebrews, Greeks, and Romans the supposed stupidity of the ass was the subject of many a proverb, and yet in reality it is one of the cleverest of the domesticated animals. Although the ass was in England in Saxon times, its use did not become common until after the time of Queen Elizabeth.

In the cold of the Arctic the reindeer is essential to the Laplander, to whom it is the only representative of wealth, those who possess a herd of a thousand or more being accounted among the wealthy. As much as 130 pounds may be loaded on to a reindeer's back. During the winter this animal feeds on a kind of white lichen that grows in the dry parts of Lapland

In the heat of India the elephant not only transports the sahib when hunting tiger, but also does good service in stacking logs and in other heavy work (Plate V). There are two distinct species of elephant, one inhabiting Asia and the other Africa. Although very similar in build, these species may be distinguished from each other by the shape of the head and the size of the ear. The head of the Asiatic elephant is elongated and the forehead concave, while the head of the African elephant is considerably shorter, the forehead convex, and the ears enormous. The trunk of the elephant is without question its most remarkable member, furnished at its extremity with a finger-like appendage so delicate that the animal can pluck a leaf or even a single blade of grass. Extremely flexible, it can be extended or contracted at will, and is possessed of enormous strength

The Asiatic elephant is extraordinarily intelligent, and although as a hauler and puller it is of no especial value, it is much used in all work that requires great strength and judgment In such an operation as piling logs the elephant soon learns how to arrange them properly, and will place them in position as accurately as any gang of workmen. But as a

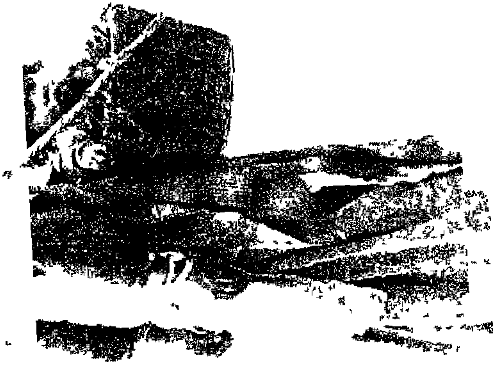
ast of burden it is somewhat unsatisfactory
nerson Tennent tells us that

although in point of mere strength there is hardly an
could be conveniently placed on him that he could
is difficult to pack it without causing abrasions th
ulcerate. His skin is easily chafed by harness, esp

FIG 2 HANNIBAL'S ELEPHANTS CROSSING THE RHONE ON
The animals are steadying themselves by gripping a special rail with th

weather. Either during long droughts, or too mı
his feet are liable to sores, which render him nor
months. Many attempts have been made to prov
some protection for the sole of the foot, but from
weight and mode of planting the foot, they have
successful. His eyes are also liable to frequent infl.

[1] Quoted in J. G. Wood, *Illustrated Natural History*, p



PLATE

I PORTAGING IN ONTARIO

5 SKI-ING ON THE MORIN HEIGHTS

Photo Canadian National Railways

BEASTS OF BURDEN

As beasts of burden oxen are referred to in 1 Chronicles xii, 40: "Moreover, they that were nigh them . . brought bread on asses, and on camels, and on mules, and on oxen" In Africa they have been educated even for the saddle, being taught to obey the bit as is a horse. The yak—a member of the ox family—is the only beast of burden that can work at the high altitudes of the Central Asian plateau—in Mongolia and Tibet. Here, on the 'roof of the world,' this strange creature exists at heights of 20,000 feet above sea-level.

The most important of all beasts of burden is the horse, which has long been used in most countries (Fig 3 and Plate IV, *A*).

The horse probably originated in Central Asia, and spread later to the Near East. In Strabo's time it was unknown in Arabia, the camel being the usual means of transport. In old Assyrian sculptures the horse is depicted as being not under the control of the rider, but led by another man

A whole volume could well be devoted to the part played by the horse in transport, but we must content ourselves with but a brief reference to its history in Britain As a pack-animal—carrying, say, 150 pounds—it was the only means of transport until the time of Queen Anne Indeed, up to the beginning of the eighteenth century a large proportion of the traffic of the country was transported by pack-horses This was a very expensive form of transport, however, and naturally only comparatively small articles could be carried. The merchandise was packed in panniers, which were slung on each side of the pack-horses. The horses travelled in gangs, which sometimes numbered fifty or more. They formed a single line, in which each horse knew his place and kept it with great regularity. Although the older horses lagged behind on a long journey, they did not break the order of their march, pushing on to the best of their ability. Many an old 'pack' died from the exertion of trying to keep pace with his companions The leading horse of the pack-train wore a bell (or sometimes a

collar of bells) and was known as the 'bell-
not only guided the horses behind when it
served to warn travellers coming in the
Generally these travellers were compelled tc
pack-horses and to stand to the side, since th

FIG. 3. A PACK-HORSE IN PERSIA TO-I

did not afford room for two streams of t
pack-horse trains met there were often q
between the respective drivers, who dispute
to step off into the mud to allow the other t

The loads carried by the pack-horses
character, and included such merchandise
sacks of meal and hops, baskets of geese, p

vegetables, fish, barrels of butter, and so on. Considerable skill was required in loading so that the goods should not be scattered on the road during the journey. Constant attention was necessary, owing to the shifting of the packs, due to the inequalities of the roads.

Merchants travelled the country on horseback selling such wares as cloths, pots and pans, and pottery As in those days there were only a very few shops in the largest towns, and none in the smaller towns or villages, the 'packmen' did a good trade. So, too, did the pedlars, who sold ribbons, laces, and fancy goods They could not afford horses, but transported their stocks on their backs They carried frames somewhat similar to our present-day camp-stools, and on these they laid out their wares when opportunity offered. In the autumn the housewife laid in a good stock to serve through the winter, because the roads were then so bad that the packmen and pedlars could not travel.

Apart from the occasional use of pack-horses for the carriage of passengers, the only practical means of travel before the introduction of coaches was on foot or on horseback. In 1617, Fynes Moryson tells us, there were post-horses in England at stations about ten miles apart, that could be hired by travellers on horseback at the charge of 2½*d* to 3*d*. per mile per day.

For centuries, therefore, the poor walked, and the rich—or, at any rate, those who could afford to do so—rode. Kings and queens, gentlemen and robbers, judges and lawyers—all rode. Royal and noble personages were attended by a long retinue of followers on horseback, all the men being booted, belted, spurred, and armed Pack-horses were included in the train to carry straps, saddles, pillions, buckles, and other necessaries in case these were required during the journey.

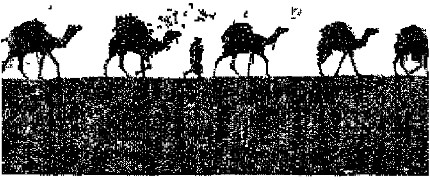
Before coaches and light carriages were introduced it was more economical to ride than to make use of any of the heavy vehicles. In the fifteenth century we find John Paston, who

was ill in London, receiving a letter from his wife asking him to return home as soon as he could bear the horse-ride—the idea of returning in a carriage never occurred to them. Women rode almost as much as men, and when they travelled they preferred to do so on horseback, and they habitually rode astride. Riding side-saddle was not introduced into England until the latter part of the fourteenth century, and even then was not general. In the Decretals manuscript in the British Museum ladies on horseback are constantly represented, and are always shown riding astride. In one place, where horses are shown being bought for a knight and a lady, both saddles are exactly the same—each with a tall back, forming a kind of chair. Later ladies were accustomed to ride on pillions, and generally behind some relative or serving-man. In this way Queen Elizabeth, when she rode into the City, was mounted on a pillion behind her Lord Chancellor.

When highwaymen and footpads became common it was no unusual thing for travellers to advertise for companions about to ride to London, so that they might travel in company for mutual protection. In an objection raised in the reign of Queen Elizabeth to a clause in the Hue and Cry Bill, then passing through Parliament, it was urged, regarding some travellers who had been robbed in open day within the hundred of Bayntesh, Berkshire, that "they were clothiers, and yet travailed not withe the great trope of clothiers; they also carried their money openlye in wallets upon their saddles."

The narrow lanes made the nefarious work of the highwaymen all the easier.

Those who were not rich and influential enough to go from castle to manor as guests had to sleep at hostelries on the road. Hospitality was freely given, however, by the numerous abbeys and monasteries, where special provision was made for travellers—in many cases this hospitality was part of their religion. Hospitality in large medieval communities was more open and general than is possible to-day in our smaller households.

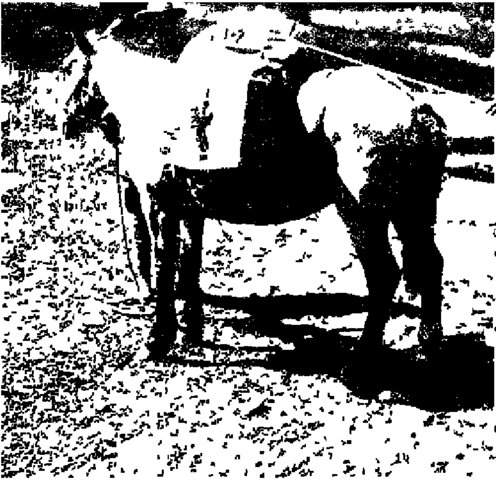


THE MARCH A CAMEL CARAVAN CROSSING TI

ORT BETWEEN TEPIE AND GUADALAJARA, ML
THE SOUTHERN PACIFIC RAILWAY WAS BUIL

C CAM AND M LE N THE KI B R PAS

Photo ndia Monthly M



4 LOADING UP THE PACK-HORSE USING THE [illegible] TO SECURE THE PACK

In books of the seventeenth century there are frequent imputations against the integrity of innkeepers, who were suspected to connive at—if not actually to participate in—robberies committed in their houses and upon the roads. In a contemporary guide the traveller is advised to find good fellows to go along with, and is warned not to stay with red-haired innkeepers!

Incidentally it may be mentioned that all travellers staying at inns had, on request, to sleep two in a bed, even though they were unknown to each other! A contemporary 'guide' advises that, when sharing his bed with a complete stranger, the traveller should inquire what part he prefers, and, having ascertained this, "let him sleep therein and do not kick about." It may be remarked that in those times no one wore a night-shirt (much less pyjamas!) in bed, nor, indeed, anything except a night-cap!

Bad though the English inns must have been, they were unquestionably superior to the inns on the Continent. Here accommodation for the traveller was provided in what were little better than barns, where the guests had to be content to lie on the floor (and considered themselves lucky if there was straw on it) in a common room with travellers of both sexes. The food was coarse and ill cooked and served in the crudest manner, the innkeeper treating his guests as though they were cattle, extorting a fabulous price, and often robbing them while they slept. On the Continent the landlord was the tyrant of those who crossed the threshold, but in England he was a servant. In English inns the bedding, tapestry, and, above all, the clean white linen were a matter of marvel. Valuable plate was often seen on the table, and outside were hung signs that must have cost £30 or £40 in many cases.

CHAPTER II

TRANSPORT WITHOUT WHEELS

MANKIND must have realized at an early date how much more satisfactory it would be if the burden-bearer—man or animal—were relieved of the task of bearing the burden and made to draw it instead.

The first draught 'animal' was man himself, and even to-day in many countries he continues in this primitive capacity (Plate XXVI, *C*). In the British Museum are Assyrian monuments showing the method of transporting huge stones by drawing them over timber baulks (Fig. 4). These baulks were taken up from behind and laid down in front of the stone as it progressed. Hundreds—sometimes perhaps thousands—of slaves strained at the ropes, the overseer driving them to greater efforts by flogging them with his lash. Fig. 4 shows the method employed in transporting on a sledge a massive stone bull. Ropes are attached to the sledge and hauled by slaves (not shown in the figure). Others place rollers beneath the runners, and others work a lever at the rear of the sledge to aid its forward progress. Standing on the monument is the foreman directing the operations, while the slaves are exhorted to 'heave together' by another man, who claps his hands to give them the 'time.'

As a draught animal the ox has rendered great service to mankind, and has been used for transport from the earliest times In the monuments of ancient Egypt and Assyria oxen are depicted drawing carts laden with produce or captives, and there are many references to them in the Bible. Oxen are still used for draught, especially in China, India, Southern Europe, and South America. In 1929 a decision was taken by the

authorities of Oporto in Portugal not to issue any more licenc
for ox-carts In Northern Portugal ox-carts have been us
since Roman times Their shape is somewhat similar to
Roman chariot, the high-set wooden axle revolving with t
clumsy wooden wheels. The ox-carts are considered

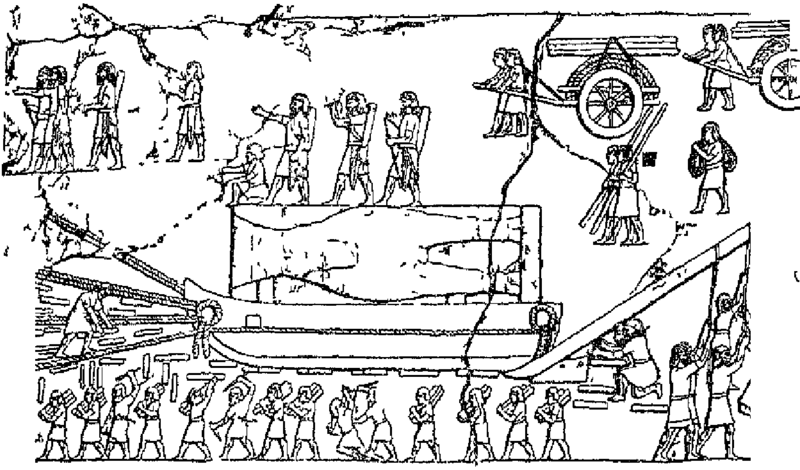


FIG 4. TRANSPORTING A STONE BULL ON A SLEDGE AT NINEVEH
Note the men at the rear aiding the progress of the sledge with a lever

obstruct motor transport in the streets of Oporto, and they w
gradually disappear.

Oxen were used in England for agricultural purposes un
the latter part of the eighteenth century In Africa also a
in North America they were employed on a large scale by t
pioneer settlers in drawing their wagons. In South Africa t
bullock wagon, with its team of a dozen or more, is a comm
means of conveyance in those parts where there are no ra
ways Oxen will draw a trek wagon through sand, over roc
and up extraordinary gradients, and even over country th
looks impossible for wheeled transport of any kind. It w
ox transport that made the great Boer treks possible. The

on record a remarkable trek by a party of Dut
ıe Boer War, who travelled as far as Kenya th
ɔuntry with no roads, bridges, or means of
ıpplies except by growing what they could on th
The life of the trek ox is not an enviable one,
ktends to more than five years During this

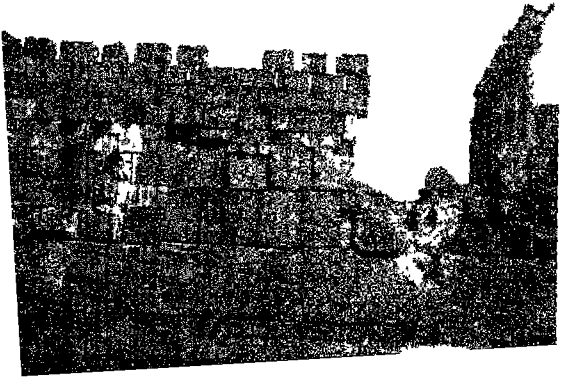
FIG 5 THE OX-CART AS USED TO-DAY IN THE ENGADI

alled upon to do much hard labour, with a heav
antly on his neck. He has to subsist mainly on
often only a dried-up semblance of what it shou
sually driven by blacks who are unsparing with
In addition to the ox, the chief animals used for
he ass, the mule, and the horse. Man has harn
ery four-footed animal to a load, but, apart from
India), reindeer (Arctic regions), llama (Peru), ze

PLATE VI

A THE WORLD'S LARGEST STONE

It lies in a quarry at Baalbec, Syria. It is [illegible] feet in length, [illegible]



and camel (Australia and elsewhere), such animals have been harnessed mostly for show purposes

The reindeer is useful as a draught animal in North Finland, Alaska, Siberia, and Canada, the Hudson's Bay Company being responsible for the experiment in the last-named country. At one time 70,000 head were employed in Alaska alone, but the stock has been gradually depleted owing to improper feeding methods, unsuitable modes of harnessing, and lack of parental selection. The reindeer could draw up to 250 or even 300 pounds on a sledge, but a humane law limits the weight to 190 pounds on a sledge and—as already mentioned—130 pounds on the back Its speed with these weights is about nine or ten miles an hour, and it can work for twelve hours at a stretch.

Dogs are used for drawing light carts in many Continental towns, and at one time they were commonly used in England for draught purposes. In Bristol in the seventeenth century goods were conveyed about the town almost exclusively in trucks drawn by dogs. This was largely because of the fact that the streets were so narrow that there was danger of coaches or carts becoming wedged between the houses and breaking through the walls into the cellars. Dogs may still be seen in Belgian towns, where they are employed to draw small carts laden with laundry, vegetables, or dairy produce. In Newfoundland dogs are sometimes used to haul fuel and wood from the forests.

The most primitive type of vehicle was the sledge, which in its earliest form was probably a log with the branches lopped off and to which thongs could conveniently be fastened. As time went on this crude form of sledge was improved, so that by the time of the first recorded sledge the vehicle had evolved to a considerable extent from its primitive form (Figs. 1 and 4). Later there were developments of the sledge, such as the travois of the Red Indians (Plate VII, *A*), which has been in use from early times. This consists of two poles—generally the teepee poles—one end of which was fastened to a horse by

a crude form of harness, and the other trailed along the ground. Skins placed across the poles formed a convenient platform on which domestic utensils could be transported.

The first sledge of which we have any record is depicted in the Temple of Luxor at Thebes. It has two long runners, slightly turned upward in front and fastened one to the other by cross-pieces In ancient Egypt sledges were used for the transport of large blocks of stone and materials required in the construction of the temples and other buildings.

Some remarkable achievements in transportation were carried out by the ancients. For instance, there was the transport of what are the largest stones ever used for building—at Baalbec, in Syria (Plate VI). These consist of three huge blocks, one 65 feet, the second 64 feet 10 inches, and the third 63 feet 2 inches in length, and all 14 feet 6 inches in height and 12 feet thick. Each block measures about 350 cubic yards and weighs 720 tons, and about eighty-two of these stones in a row would be required to cover a mile. They were all moved three-quarters of a mile and built into one of the walls of the Temple of Bacchus at a height of 19 feet above ground level. In the quarry from which these stones came lies a hewn stone of monster size—69 feet by 16 feet by 13 feet 10 inches, and estimated to weigh no less than 915 tons—to move which would, one imagines, cause a modern transport manager considerable thought!

The method employed to transport these gigantic stones is a mystery. It has been suggested that they were lifted into position by machines, the secret of which has been lost, or that an inclined plane was built between the temple and the quarry and that these enormous stones were made to slide down on iron rails, the friction being diminished by the use of wheels and stone rollers. If an inclined road was built, stones of a certain size must have been used for its construction, but there are no traces of the road or the material of which it was formed. Some architects think that the stones were hoisted

to a great height by a scaffolding built with the trunks of trees and by the use of some machine resembling the modern crane. It is significant that in all these blocks, and in the columns in the temple, there are either square or oblong holes that may have been used for hooks or rings. These may have been fastened into the holes, and chains or ropes fastened to the rings for dragging or lifting the stones.

No people of early times could lay better claim to being familiar with the methods of transporting and handling huge masses of stone than the ancient Egyptians.

It is in the famous Pyramids that we find the finest examples of transport achievements in ancient Egypt. The Pyramids, which were one of the Seven Wonders of the ancient world, were built by Menkaura, Cheops, and Kephren, who ruled from 2500 to 2200 B.C The Pyramid of Cheops possesses the distinction of being the greatest mass of masonry ever erected. It originally measured 768 feet square and rose to a height of 482 feet—that is, 117 feet higher than St Paul's Cathedral It is estimated to contain 2,300,000 separate blocks of stone, each averaging 40 cubic feet, or sufficient stone to build a city of 22,000 houses of an average size If the stones were cut into 1-foot cubes and placed end to end the line would extend for 17,000 miles—two-thirds of the distance round the earth at the equator! The stones above the roof of the central chamber are 19 feet in length, 3 feet to 4 feet in depth, and 2 feet in breadth, and many of them weigh some 50 to 60 tons Yet they fit together perfectly, embodying in their arrangement the principle of the arch, to withstand the pressure of the great weight above Not only were these huge stones transported from the quarries to the site they now occupy, but also they were raised nearly 500 feet.

The historian Herodotus tells us that an inclined road of polished stone was constructed from the banks of the Nile to the site of the Great Pyramid—about three-quarters of a mile —for transporting the blocks brought down the river from the

Arabian mountains. He further states that for ten years 100,000 workmen were employed three months annually in constructing this inclined road and in the excavation of the subterranean chambers. Herodotus expresses the opinion that the construction of this roadway was a scarcely less notable work than the building of the Pyramid itself.

The erection of the Pyramid took the hundred thousand workmen a further twelve years. Although this large number was employed for only three months in the year (corresponding probably with the period when the Nile was in flood, and when agricultural labour was consequently at a standstill), a great number of workmen must have been employed all the year round in the quarries and on the Pyramid itself, cutting and dressing the stones. Herodotus tells us that in his day the Pyramid was covered with polished stones, well jointed, none of which was less than 30 feet long. This Pyramid was first built in the form of a flight of steps. After the workmen had completed it in this form they raised the other stones by means of machines, made of short beams, from the ground to the first tier of steps[1] After a stone was placed there it was raised to the second tier by another machine, for there were as many machines as there were tiers of steps. The highest part of the Pyramid was thus finished first, and the parts adjoining it were taken next, and the lowest part, next to the ground, was completed last. If the inclined road were used, which would not seem altogether necessary in view of this statement, the incline would have had to be increased from time to time, for as the work proceeded the Pyramid would gain in height.

In England a century or so ago, when carts were not so numerous as they are to-day, it was customary to load hay, wheat, and other produce on light sledges for transport from the fields to the farmyards. Even to-day sledges are in use in some parts of the country for this purpose, and also for the

[1] This was an application of the principle of the lever, and was an early form of the modern crane.

I RED INDIAN TRAVOIS

He wakes in the winter and his family is ready for the road

Photo Baltimore and Ohio Railroad Company

A UNIQUE AND PICTURESQUE "CARROS," OR [illegible]
ON THE QUAYSIDE AT FUNCHAL, MADEIRA
These sledges glide over the basalt cobblestones [illegible]

R [illegible] TRANSPOR[illegible] N [illegible] O [illegible] BY [illegible] ED

transport of timber In many countries they are used all the year round for logging and similar heavy work on hillsides, where it is not possible to use any form of conveyance that depends upon wheels (Plate VIII, *B*). In Siam they are used to convey the produce from the rice-fields to the villages A model of this type of sledge may be seen in the Science Museum, South Kensington. It consists of a square platform mounted a short distance above the ground on bent bamboo

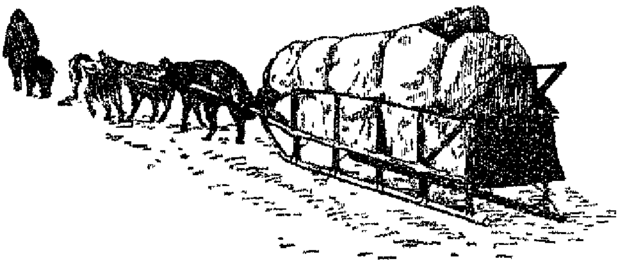


FIG 6 AN ESKIMO SLEDGE

runners. These serve as shafts, and to them a water-buffalo is yoked In Switzerland and other mountainous regions sledges are used to bring fuel and faggots to the valleys

Sledges are, of course, in use in countries of perpetual snow, where wheeled vehicles would sink and be dangerous over ice (Fig. 6). They are the usual means of transport in North America, Northern Europe, and in Russia, during the winter months, and in many places they offer the only practical means of bringing in food and fuel. A simple sledge when drawn by a reindeer may be run with amazing swiftness, the passenger guiding the animal with a cord fastened to the horns Reindeer can travel fifty or sixty miles at a stretch if urged to do so, and frequently have been known to cover 120 miles in a day.

Sledges have played an important part in polar exploration

(Fig. 7), and were used, in varying degree, by Si
Sir John Franklin, and other early explorers of t
Sledge-travelling also played a great part in th
the North Pole by Robert E. Peary in 1909. The
ward commenced in the middle of Februar
journey over the ice was made in sections, th

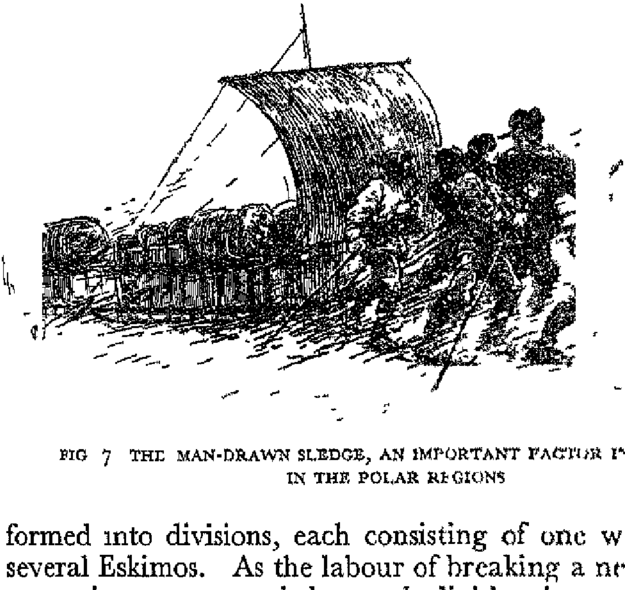


FIG 7 THE MAN-DRAWN SLEDGE, AN IMPORTANT FACTOR I
IN THE POLAR REGIONS

formed into divisions, each consisting of one w
several Eskimos. As the labour of breaking a ne
severe it was arranged that each division in tur
of the leader himself, should pioneer the way o
surface before returning to the base. This me
most of the journey of 470 miles Peary's own p
travelling in comparatively easy circumstances, a
be in good condition for a great final effort.

The ice was not unusually rough, but it was c
to use pickaxes to cut a way through the ridges
500-pound sledges almost bodily over the humr
'leads' (lanes of water) were encountered they

by using detached fragments of the floe. As each division fulfilled its mission of transporting supplies and easing the way for the party intended to reach the Pole it returned south, until at last the day came when only the division in charge of Peary remained

The final spurt proceeded as arranged, and on April 6, 1909, Peary's little party stood within five miles of the Pole As it was impossible to fix position at the Pole with accuracy by observations of the sun, owing to its low altitude, Peary traversed the ice in various directions within a circle ten miles in diameter, the centre of which was the position indicated by his observations. At some moment during these marches he passed over, or very near to, the point where north, south, east, and west become one. After remaining thirty hours at the Pole, during which time observations and photographs were taken, the homeward trail was struck, and land was reached sixteen days later.

Captain R. F. Scott and Sir Ernest H Shackleton both used sledges in their Antarctic expeditions. In the Science Museum, South Kensington, is one of the sledges used by the former in his expeditions of 1910-13 It is of the type designed by Dr F. Nansen some years earlier, is 12 feet in length, 22 inches in width, and 7¾ inches in depth. Its weight is 48 pounds, the normal load for such a sledge being about 600 pounds, which could be hauled by three men. Sledging man-harness, as used by both Scott and Shackleton, is also to be seen in the museum. With it hauling is done from the waist, and not from the shoulder, as in previous practice. The harness consists of a wide canvas waist-belt, supported by canvas braces passing over the shoulders. The ends of the belt are provided with eyelets, through which the end of the hauling rope is passed and then spliced into a loop. The other end of the rope is looped for attachment to the sledge trace.

Dog-drawn sledges (Plate IX) are able to attain surprising speeds, and in Canada during the winter races—or dog-sledge

'Derbys' as they are called—are held at Manitoba, Banff, Quebec, and elsewhere

Dog-sledge teams played a part in the sensational rush that followed the reported discovery of a rich deposit of gold at Red Lake, Ontario, in 1926. The locality of the 'find' was an isolated place 130 miles north-west of Hudson, a station on the Canadian Pacific Railway. Those who utilized dog teams in order to reach Red Lake had a hazardous journey across regions practically devoid of any recognized trail. Blizzards, snow-drifts, and intense cold added to the perils of the enterprise. When camp was struck for the night the dogs were generally chained to trees, and they made the night hours hideous with their wailing cries Incidentally it may be mentioned that this particular gold rush is of interest also as being the first in which prospectors utilized aeroplanes.

The Husky and Malamute dogs of Alaska are particularly well suited for sledge work, and others have been so used since before the advent of Western explorers through Canada, Alaska, Greenland, and Northern Siberia, only giving place to reindeer haulage in Lapland and the adjoining regions. For journeys across the snowy interior the Husky is usually regarded as the more suitable, while the Malamute, on account of its comparatively short legs, does better over the hard snows of the coast. The coats of these dogs are short, but sufficiently thick and dense to provide ample protection from the intense cold. The Malamute is a pure-bred Eskimo dog, whereas the Husky's origin appears to be somewhat uncertain. A notorious characteristic of the Malamute is its fighting ability, for, though a faithful and agreeable companion, it is extremely jealous of divided affection and shows its feelings very plainly! Bushy tail, alert narrow eyes, sharp muzzle, black nose, and erect ears, all help to give it a distinctive appearance. When well fed and cared for, and its silver-grey coat properly tended, it is a very handsome dog and will turn the scale at probably 80 to 85 pounds.

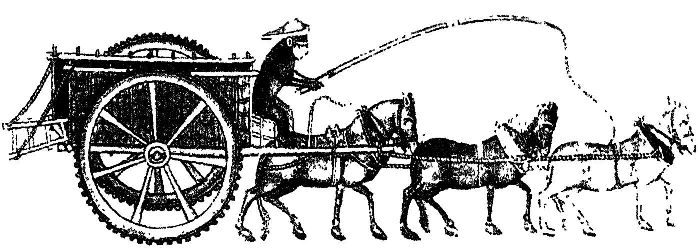
[illegible] RESTING ON THE [illegible]
NORTHERN ONTARIO

PLATE X

A. THE ENTRANCE OF QUEEN ISABELLA OF FRANCE INTO PARIS IN A HORSE-LITTER

Late fifteenth century.

From Froissart's "Chronicles"



B. COUNTRY CART DRIVEN BY MONKEY

About A.D. 1340.

TRANSPORT WITHOUT WHEELS

The Malamute dogs of Alaska are closely akin to the Eskimo dogs of Greenland and Iceland, to the splendid qualities of which more than one expedition over the ice wastes of the Arctic has owed its safety. In size the Eskimo dog is almost equal to the mastiff, its sharp-pointed muzzle and bushy tail affording a good indication of the animal's alertness and splendid physique.

The notoriously savage temper of the Eskimo dog has been attributed by some authorities to its wolfish antecedents, and by others to the marked indifference displayed by the Eskimos to the hunger of their dogs, resulting in the animals' barbarian tactics to obtain food During the summer months the dogs are generally released from service and allowed to roam about and fend for themselves At the approach of winter the animals return to their masters. During their months of service they often have a lean time of it, sometimes subsisting on little more than dried fish-heads carelessly thrown to them Thus, by force of circumstance, the Eskimo dogs have developed the ability to go for remarkably long periods without food, which characteristic has been commented upon by many explorers

The dogs are fastened to the sledge by a harness usually of raw hide. It is arranged so that the dogs pull in pairs on each side of the central trace, the team being led by a single dog, chosen for his sagacity and fighting qualities that enable him to enforce discipline on the remainder of the team. There is another form of harness by which the dogs are arranged fanwise, with the leader in the centre and somewhat in advance.

Before concluding this chapter we must mention two other forms of transport that were in use before wheeled vehicles became popular. These are the litter and the sedan chair.

The litter, which was in use in very early times, was virtually a sledge lifted from the ground, slung on poles, and borne by two or four men, or later by mules or horses. It was of

great service when a path was too narrow, or a road too bad, to allow a wheeled vehicle to be used.

The horse-litter was much patronized in England and on the Continent by ladies of rank, and also by aged and sick persons (Plate X, *A*). As a rule it was borne between two horses and suspended from two poles fixed to pack-saddles The body of the litter, which was no wider than the space between the poles (about 2 feet 6 inches), was from 4 to 5 feet in length and afforded accommodation for one person only. Usually a covering was affixed, an entrance being obtained in the centre from either side. Sometimes even sliding doors were fitted, and there were openings at the sides and ends for air and light

The horse-litter is referred to by many of the old chroniclers William of Malmesbury, for instance, tells us that in 1100 the body of William Rufus was carried on a horse-litter after his death in the New Forest. According to the manuscript ascribed to a Matthew of Westminster, King John, when he fell ill at Swinestead Abbey in 1216, was taken in a horse-litter to Newark, where he died In general, however, the horse-litter was used only by women, and any men who used it were regarded as being effeminate.

According to Stow, the horse-litter went out of use when the side-saddle was introduced by Anne of Bohemia, Richard II's queen. The historian tells us that "riding in those whirlicotes and chariots was forsaken except at coronations and such like spectacles." The litter remained in use, however, until the time of Charles II In 1638 Marie de' Medicis, the Queen-mother of France, entered London in a litter, although she had completed the journey from Harwich in a coach. Even as late as 1680 we learn that "an accident happened to General Shippon, who came in a horse-litter wounded to London; when he paused by the brew-house in St John Street a mastiff attacked the horses, and he was tossed like a dog in a blanket!" [1] But even at this date the wheeled

[1] Straus, *Carriages and Coaches*, p. 55.

ge had long been the state vehicle, and eve
tion (1553) Queen Mary was drawn in a chari

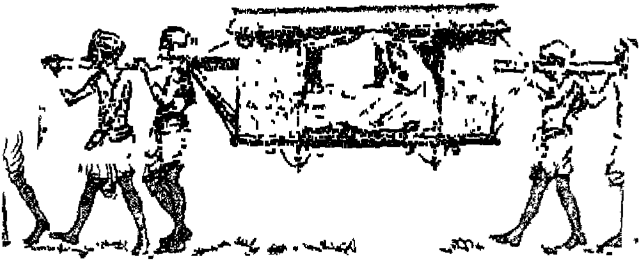


FIG 8 A PALANQUIN IN INDIA
n Wyman's *Bemol and Kusum* Copyright 1925 by the World Book Comp
Publishers, Yonkers-on-Hudson, New York

e have been various modifications of the litter,
es being the funeral bier and the modern s
r development is the palanquin, a distinctive
ort in the East (Fig. 8). In the African jun
ncd travellers or sick
are carried in a ham-
lung on a long pole
rne on the shoulders of
men. Other modifi-
are met with in various
es, and particularly
he ground is so rough
lly as to make wheeled
rt inconvenient or dan-
Plate X, *A*).
nother development of
r was the sedan chair

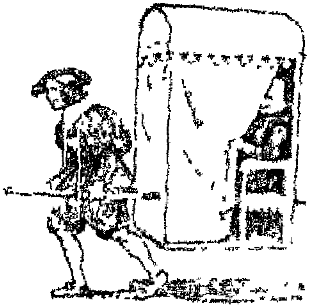


FIG. 9. EARLY FORM OF SED
(SHOWING THE BEARERS'
STRAPS)

, the origin of which is unknown. The seda
e chair with side windows, entered through a
the front and having a hinged roof to facilita
It was carried by two 'chairmen' by means

zontal poles which passed through sockets fixed at each side. In Paris the chairmen were generally Auvergnats, and in London Irishmen The first sedan chair is said to have belonged to the Emperor Charles V, in the first half of the sixteenth century In England the period of its greatest popularity was the eighteenth century, although it had been introduced, according to some, as early as 1581 By others its introduction into England is credited to the celebrated Duke of Buckingham—that unworthy favourite of two kings—who is said to have brought three chairs back from Spain, which country he had been visiting with Prince Charles.

Although they could not have been very comfortable, these chairs had certain advantages—especially in those towns where the streets were narrow. They soon became popular, in spite of some opposition to them at first.

In the first chairs the poles were carried on the shoulders of the bearers, but soon this was altered and the poles were carried in the hand, leather bands being passed round the shoulders to help to support the weight of the chair. The poles were so arranged that the chair could be carried up and down stairs in a horizontal position The sedan was thus a great convenience to invalids, for it could be taken into the sick room and the invalid conveyed without exposure to the outer air, to medicinal baths or elsewhere for treatment.

Private chairs were often luxuriously upholstered and beautifully decorated, some of the greatest French artists not disdaining to embellish their panels. Often the outside of the chair was painted and gilded and the inside lined with crimson velvet. Public chairs were made of leather—generally black or dark green—stretched over a wooden frame.

Latterly the sedan became much larger and consequently more ungainly. Dickens tells us of a chair that was "originally built for a gouty gentleman with funded property, would hold Mr Pickwick and Mr Tupman at least as comfortably as a modern post-chaise!" This was on the occasion when Mr

Mr Tupman were arrested at Ip
Mayor's house in the chair in questio
seems to have disappeared fiom Lon
if the nineteenth century. In 1836

) A TYPICAL STREET SCENE IN GEORGIAN ENGLAND
The Palace Gate, St James's, London.

"Sedan chairs appear to have fi
St James' Street Even in 1826 I sa
as since vanished." [1]
of the sedan (Fig. 10) the streets of Lon
eary after nightfall that it was a positi
ors. Those who travelled by sedan

[1] *Sketches of English Society.*

themselves by hiring 'linkmen,' who carried torches or lanterns to light the way On the railings of a few old London houses

FIG. 11. LINKMAN EXTINGUISHING HIS TORCH

are still to be seen the iron fixtures in which the linkmen extinguished their torches when their duty was done (Fig. 11)

CHAPTER III

THE FIRST WHEELED VEHICLES

FROM ancient Egyptian illustrations of later forms of sledge transport it is clear that an attempt to reduce friction was made by the introduction of rollers between the runners and the ground, as we have seen (Fig. 4). Wooden rollers were placed in front of the sledge as it progressed, and were taken from behind when it had passed over them, thus allowing it to be more easily moved forward. Rollers, in the form of tree-trunks, were probably used in this way from the earliest times in moving heavy masses of stone. Continued progress could be maintained by the use of only three rollers, and by slewing the leading roller before it took the weight the stone could easily be steered in any direction, or round obstacles.

The exact date of the invention of the wheel we do not know But once the rollers became attached to the sledge no great interval can have elapsed before it was borne in upon man that a roller was neither necessary nor desirable, and that two 'slices' from its extremities would serve the same purpose equally well. As far as can be ascertained rollers were superseded by wheels and axles somewhere between 4000 and 1500 B.C.

The first wheels consisted of solid discs, and wheels of this type are to be seen to-day in many places in the East—in Burma and Bengal, for instance, they are in common use. In some parts of America and in other countries these wheels are literally nothing but transverse slices cut off from the trunk of some large tree. Larger wheels were adopted when it was found that obstacles were more easily overcome by this means They were made of planks fastened together, instead of being

one-piece discs Wheels of this kind—planks of wood, secured by cross-pieces and roughly cut into a circle—are to be found in the West of Ireland to-day

The primitive wheel was firmly wedged on to the axle, so that wheels and axle revolved together below the cart The axle was held in position by wooden pins in the body of the cart, exactly as oars are held in position in a boat by the row-locks The practice of thus fixing the wheels on the axle still continues, and carts with wheels and axle in one piece are used in Spain, Portugal, South America, and elsewhere. The same device is employed in tramcars and railway-carriages.

Evidently carts with fixed wheels and axles had not been long in use before the defects of their construction became apparent —especially when the cart was turning a corner. The axles were thereupon fixed to the body of the cart, and the wheels allowed freely to revolve on them independently of one another

The spoke may have originated from the practice of inserting a lever through a hole in the disc wheel to give assistance on a rough road or with a particularly heavy load. The advantages of having several holes at different places in the disc would then be obvious, and it was probably in this way that the crude spoked wheel originated. Finally a wheel of three pieces was evolved—a central pierced piece, the nave; the outside rim, or felloe, and the cross-pieces, or spokes. This design, besides reducing the weight of the wheel, rendered possible a greater circumference—a decided advantage, for a large wheel moves with less friction than a small one. The skilful construction of spoked wheels gradually improved, and in some cases they were the subject of beautiful workmanship.

Subsequently the wheel was further improved and greater strength obtained by making it dish-shaped. In the first wheels the spokes all lay in one plane, springing at right angles from the nave, so that viewed at right angles to the line of axis they appeared flat. By means of this 'dishing' of the spokes, or making the wheel concave on one side and convex

on the other, the form changed to a conical surfac only does this give greater strength, but more space is between the wheels for the body of the vehicle, and a which may be encountered is thrown off the rim aw the vehicle.

Although bent timber in either one or two pieces s an early date as the rim of the wheel, it was not used in times for this purpose until (first by Joseph Jacob) 1769. In the Cairo Museum of Antiquities is a chariot wheel (Fig. 12) found in the tomb of Iuaa, father-in-law of Amen-hetep III, who lived about 1400 B.C. For five-sixths of its length the rim is in one piece of wood, which was probably steamed and bent into shape, and is completed by the jointing-in of a shorter piece, the joints being covered with gilded plaster.

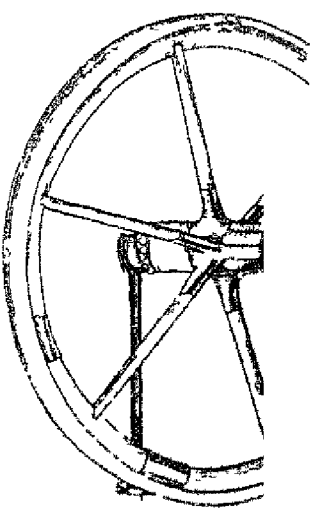


FIG. 12 REPLICA OF ANCIENT CHARIOT WHEEL

In a two-wheeled vehicle the weight, as far as possible, must be balanced over the axle, so that no undue burden falls on the animal drawing it. Four-wheeled vehicles were introduced in order to carry greater weights than was possib two wheels. The addition of an extra pair of wheels ena vehicle itself to support the whole weight of the load, the animal free to draw it along. To overcome the that arises in turning a vehicle with wheels that maint same relative positions, the front pair of wheels are m with a pivot in the bar carrying the axle. This enabl to accommodate themselves to any change in direction

animal drawing the vehicle, the rear wheels following more gradually. This arrangement necessitates the front pair of wheels being made smaller than the rear wheels, so that they will turn under the body of the vehicle when the direction of its travel is changed. The friction is increased by this arrangement, however, for the smaller a wheel the more often must it revolve to move over a given distance, and the greater is the friction at the axle.

Wheeled vehicles were in use in Egypt at a very early date, and are several times mentioned in the Bible. The word for any vehicle carrying persons is either 'wagon' or 'chariot,' and that for any vehicle carrying goods is generally translated as 'cart.' The wagon is first mentioned in the Bible in the account of the preparation for Jacob's removal to Egypt.

The appearance of the ancient Egyptian vehicles is known to us from numerous paintings and sculptures on the walls of the temples and tombs, but as these early sculptures are more often representations of battles than of domestic scenes, we know a great deal more of their chariots than of their carts. In a tomb at Thebes is depicted a travelling car, carrying an Ethiopian princess to the Egyptian Court. This was probably the same type of vehicle as the "wagons" sent by Joseph to Canaan, and similar to that in which Strabo, the Greek historian, made a journey in Egypt. This vehicle was very similar to the war-chariot, but had closed sides and was drawn by a pair of oxen instead of by horses. The wheels had six spokes, and over the body was a kind of umbrella, fixed on a rod rising from the central or back part of the car. The harness was simple, the reins being similar to those used for horses and furnished with a bit.

The light chariots (Fig. 13) of the Egyptians enabled them to secure the fullest advantage from the speed and breeding of their horses, which at that time were considered to be the finest in the world. The Egyptian chariots were sometimes square, but more often they were semicircular or horse-shoe shape,

with the curved front towards the horses. The sides were lower than the front, and the floor was near to the ground, making it easy to step in and out. Usually the wheels were from 2 feet 6 inches to 3 feet 3 inches in diameter, and the body was either open or covered with skins or basket-work. The car was supported by a pole, which, curving upward, joined a wooden yoke fitted on the necks of the horses. Sometimes

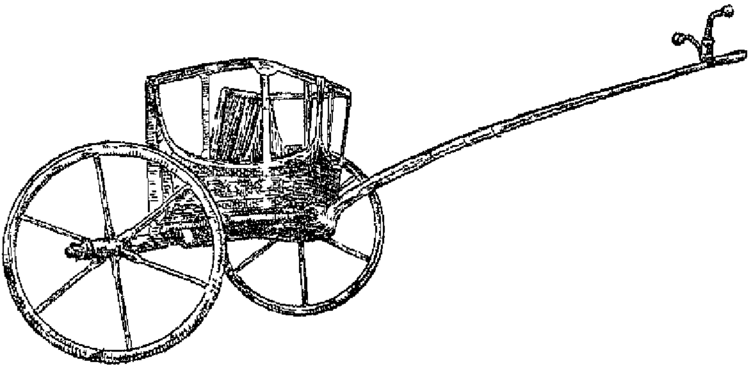


FIG. 13 A LIGHT EGYPTIAN CHARIOT

the horses were attached to an iron bar, which passed through a ring at the end of a pole, giving them more freedom in motion than they obtained with a fixed yoke. These chariots carried two persons standing upright, and as there was no springing, and as the wheels were small, riding in them must have been very uncomfortable—to say nothing of the mud and dirt to which the occupants would be exposed by being so near to the ground They were used in vast numbers, however, and they were capable of being driven at a great speed—practically as fast as the horses could gallop. They were particularly useful in the narrow streets of the cities and on mountain roads, which were often only about 4 feet in width. They were regarded as a valuable part of an army's equipment, and seem to have been used in warfare even before mounted horsemen were employed.

Chariots were introduced into Egypt by the Hyksos, or Shepherd Kings, in the eighteenth century B.C. They were not common by the Nile, however, until 1600 B.C. at the rise of the Egyptian Empire two centuries later. Thus, when Tutankhamen's craftsmen, in the middle of the fourteenth century B.C., made the magnificent chariots that were found in his tomb, this type of vehicle had been in use in Egypt for about 250 years. The chariots of the Assyrians were similar to the Egyptians' except that they were completely panelled at the sides and sometimes had a shield at the back.

The chariot spread from Egypt to other countries, and was used extensively in war on the plains of Asia. The type of vehicle illustrated in the Egyptian sculptures seems to have been in more or less common use throughout the ancient world, and it existed as a general means of transporting man for at least 2000 years.

There is a general similarity between the chariots of the Egyptians and those of the Greeks and Romans. Although we read of solid metal chariots, both brazen and bronze, the Greek chariots were generally made of wood. Hesiod, who flourished in Greece about 735 B.C., records that not less than a hundred varieties of wood were used in their construction. Sometimes the framework of the chariots was of brass, and the two wheels were sometimes of wood and sometimes of metal. The body was open at the back, but without a seat, and usually two persons were carried, one to drive and the other to fight.

The chariots used in war by the early Greeks were carved in front and rather higher than those of the Egyptians. Around the inside of the body there was fitted a curious basket-like rim, on which the passengers could sit. In these Greek chariots there was never more than one pole, although the Lydians used two, or sometimes even three, poles. Chariots were used at the siege of Troy, and Homer tells us that the chief warriors on both sides went into battle and fought from their chariots. In later times the Greeks used chariots only for

processions, on state occasions, or for amusement. Chariot-racing formed an important part of the Olympic games. Erectheus, King of Athens, is reputed to have been the first to drive four horses, but it later became general in the chariot races to attach four horses to each chariot. Occasionally even five horses were yoked abreast.

Later other types of carriages were used by the Greeks, and some are illustrated in the famous Elgin Marbles. Such

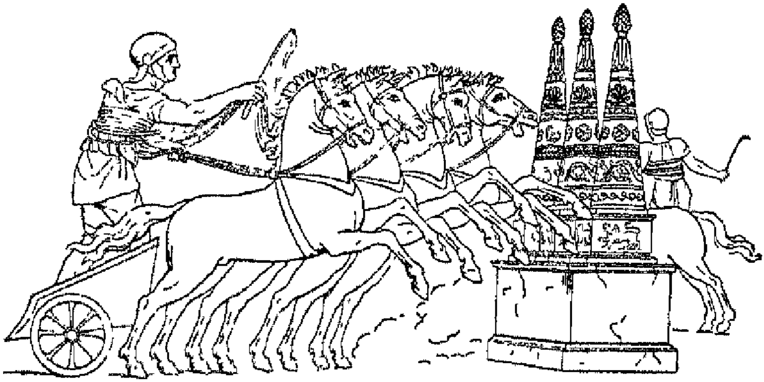


FIG. 14 A FOUR-HORSE ROMAN RACING CHARIOT

carriages were used in the state processions and often were built of ebony or other fine woods. They were covered or inlaid with ivory, gold, or silver-gilt, or were adorned with bas-reliefs, pictures, and statues. The insides were generally richly ornamented and decorated with materials of silk, velvet, and tapestry of the richest colours, wrought with gold, silver, pearls, or precious stones. On the seats and floors were spread soft skins and luxurious cushions. These vehicles included state carriages, 'family sociables,' wagons, and litters. The *apene*, a light carriage largely used by the Grecian ladies, had two or four wheels and was drawn by four or more horses. It was enclosed by curtains, which were carefully drawn to hide

the passengers, and the interior was fitted with cloth, leather, or goat-skins.

As the Romans increased in power they adopted the war-chariot, or *currus*, which the Etrurians in the neighbouring country had used for many years. In passing we may mention that the Etrurians are believed to have been the first people to place an awning over the open car. The *currus* was drawn by two or more horses—sometimes four were used without pole or yoke. In addition to the *currus* the Romans had a variety of other vehicles, and, realizing their importance for military and other purposes, they constructed a system of wonderful roads [1]

One of the earliest of these other vehicles was a four-wheeled wagon called the *arcera*. This was chiefly used for carrying agricultural produce, and for the transport of goods and baggage, or arms and valuables taken from the enemy. According to Plutarch, the Roman Consul Emilius had 750 wagons when, in 170 B C., he brought home the spoils captured from Perseus the last king of Macedonia One of these wagons depicted on the Trajan Column at Rome shows a large square basket on four wheels, the rear wheels being a little higher than the front wheels.

Another vehicle popular with the Romans was the *essedum*, the war-chariot of the ancient Britons, brought to Rome by Julius Cæsar This chariot is supposed to have been introduced into Britain by the Goidels some 700 years B.C. It did not at all resemble the Egyptian chariot, on which the Roman *currus* was based, for it was fitted with a seat—from which it derived its name—and had larger wheels. The entrance was in front instead of at the back, and the pole did not end in a yoke on the horses' necks, but was horizontal. It was so wide that the driver could stand on it, and if necessary could drive from the end of the pole, or leap off it and stand before the horses Of these chariots Cicero wrote, "There appears

[1] The Romans introduced paved roads about 300 B.C

to be very little worth bringing away from Britain except the chariots." The *essedum* attracted considerable attention among the Romans, and, beautifully decorated, it became the fashionable pleasure carriage It was used also as a travelling carriage by emperors and generals and could be hired at posting stations. In later times it was much used for the speedy carrying of dispatches to the more distant parts of the Roman Empire in France, Spain, and Germany.

The *essedum* is of particular interest inasmuch as it is considered to be the prototype of all vehicles of the curricle or gig class The first development in this direction was the Roman one-horse *cisium*, which bears an extraordinary resemblance to the modern gig. It was a kind of cabriolet with two, three, or even four horses, and became the most popular Roman vehicle. It was the post-chaise of the Roman Empire, and in due course was fitted with very large wheels for the purposes of speed The seats were soft-cushioned and suspended by straps to minimize the jolting Seneca (4 B.C.–A.D. 65), the famous Roman philosopher and tutor to Nero, said, "You may ride long and comfortably in the *cisium*."

Another comfortable carriage, the *pilentum*, had a canopy roof supported on four light pillars. Pliny mentions the *carruca*, a four-wheeled carriage of Imperial Rome, used both in the cities and for long journeys and resembling the phaeton, so popular in England towards the close of the eighteenth century. Nero travelled with great numbers, and on one occasion was accompanied by no less than three thousand. Many were gorgeously decorated with bronze, silver, or gold The word *carruca* was the origin of the English word 'carriage,' of the French *carosse*, and of the Italian *carozza*.

In Anglo-Saxon times distinguished persons travelled in chariots, but they must have found them a very uncomfortable means of transport. Agricultural produce was conveyed in carts long before wheeled vehicles were used for passengers.

Carts are first mentioned in England in the *Cartulary of*

Ramsey Abbey, from which we learn that on certain manors in the time of Henry I (1100–35) there were included "three carts, each for four oxen or three horses."

Although the old chroniclers often used the word 'carriage'[1] they did not intend it to have its modern meaning. In those

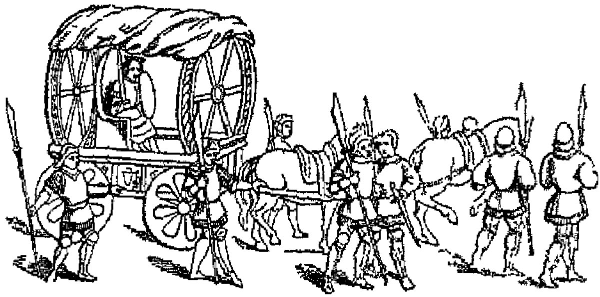


FIG 15 A STATE CARRIAGE OF THE FOURTEENTH CENTURY

days a carriage might have been anything on wheels—as, for instance, an agricultural wagon or simply a baggage-cart.

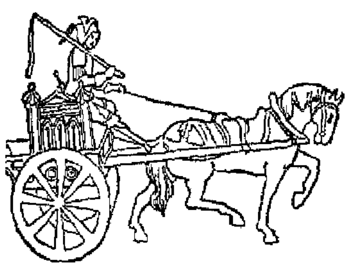


FIG 16. A TRAVELLING CARRIAGE OF THE FOURTEENTH CENTURY

Thus, when we read of some great personage making a journey accompanied with numbers of 'carriages,' we must remember that these were simply luggage-carts, each consisting only of a square wooden box mounted on two wheels. Even the carriage of King John (1199–1216), for example, was of the most primitive construction and without springs. The body rested directly on the axle, the wheels being to all appearances cut out of solid pieces of wood, ornamentally carved and bound with a thick wooden

[1] 'Carriage' is the corruption of the old English word 'caroche' or 'caroach,' originally derived from an Italian word *carro*, 'a car,' and later abbreviated into 'coach.'

tyre. Travelling in such early carriages must have been an uncomfortable experience, for there were no springs (Figs. 15 and 16), and the jolting over the rough roads could only be minimized by the use of cushions.

The mode of thought under the feudal system had a great deal to do with the fact that carriages did not become popular. In those days every one rode horses or mules—masters and servants, husbands and wives, clergy and laity. It was of the greatest importance to the feudal lords that their vassals should be always able to serve them as horsemen, and they thought that if they rode in carriages horseback-riding would become uncommon and men would become unfit for military service In 1294, in the reign of Philip the Fair of France, a law was passed forbidding the use of coaches, the idea being that the lolling in comfort in decorated carriages would result in the degeneration of a race of hardy horsemen The prejudice continued for a long time, and in 1564 we find Pope Pius IV exhorting his cardinals and bishops not to ride in the new coaches, but to leave them to women. Edicts were issued and laws made against the indolence of riding in coaches, and all and sundry were impressed with the fact that they should travel on their riding-horses. In the sixteenth century the public entry of any noble personage into any place, or departure from it, was nearly always made on horseback. All works dealing with the Papal ceremonies mention state horses or state mules, but there is no mention of a state coach or body of coachmen

Wheeled carriages for pleasure were not introduced into England until the reign of Queen Elizabeth, and the Queen's own vehicle was the first to be distinctly called a 'coach.' It was in this coach that the Queen drove from Somerset House to St Paul's Cross to return thanks for the destruction of the Spanish Armada. Her attendants rode in another carriage, in which were two 'boots'—or odd-looking seats—for two of her officers. The Queen's coach had four spoked wheels set

in a thick wooden rim. When we consider the state of the roads at that time, and that the coach was devoid both of cushions and of springs, we may form some idea of the discomfort it occasioned. As carriages soon became fashionable, however, such discomfort was patiently borne

Without springs, and pitching over stones and into ruts, these wagons, as they were fittingly termed, must have resembled ships in a heavy sea. We are told that the passengers were "tossed, tumbled, rumbled, and jumbled about in them." Roads were no respecters of persons, and it was not uncommon for juries, prisoners, and court officials to be kept waiting while the judge's carriage was dug out of a bog or hauled out of a ditch by farm-horses! Some attention was given to the passage of royal personages, for when a king or queen made a journey by road it was the custom for all the labourers and masons to turn out to repair the roads and bridges, so that they would be secure at least until the royal party had passed!

CHAPTER IV

STAGE-WAGONS, HACKNEY-CARRIAGES, POST-CHAISES, AND CABS

Long wagons,' 'wains,' or 'machines,' as they were sometimes called, were introduced into England about 1564. Used regularly for the transport both of goods and passengers between the chief towns, these wagons developed into roomy vehicles, capable of carrying about twenty passengers as well as goods. Some had 'boots' projecting at the sides, and probably 'outside passengers' were carried at a lower fare than that paid by those who travelled in the main part of the covered wagon. The wheels were broad, and the wagon was drawn at a walking pace by six, eight, or even more horses, which usually completed the entire journey without being changed. These wains at first carried a heavier class of goods than that carried by pack-horses, and later, when the stage-coach was introduced, they continued to be used for less urgent transport than was coach-borne. They continued to carry the great bulk of the merchandise of the country (where water transport was not available) until the coming of the railways.

The long carrier's wagon—known as a 'stager'—was the only vehicle for conveying travellers until the middle of the seventeenth century, when the stage-coach was introduced Stagers had neither seats nor furnishings, straw being littered on the floor, on which the passengers could sit or lie during the weary hours of the journey. The wagons were so cumbersome, and the roads were in such a deplorable condition, that the rate of travel was only about ten to fifteen miles a day Despite this slow rate of progress the stage-wagons were a great convenience in a country in which travel and transport

were matters of considerable difficulty. By 1640 stage-wagons had increased their rate of travel to about four miles an hour. About this time a string of stage-wagons travelled regularly between London and Liverpool, starting from the Axe Inn, Aldermanbury, every Monday and Thursday. Ten days were required for the journey in summer, and generally about twelve days in winter.

Later light wagons known as 'flying wagons' were introduced[1] A curious old English road-bill, dated 1774, ends with the sentence: "The Rumsey Machine, through Winchester, hung on steel springs, begins flying on 3rd April from London to Poole in one day." On November 16, 1776, Matthew Pickford advertised that his flying wagons travelled from Manchester to London in 5½ days—the rate of travel being thus about 1½ miles an hour. The wagons left the Swan and Saracen's Head, Market Street Lane, Manchester, on Wednesdays at 5 P M, and arrived at the Swan with Two Necks, Lad Lane, London, at noon on the following Tuesdays In the following year this time was reduced to 4½ days The Swan with Two Necks was a famous inn in the days of carriers, and later, in coaching days, also. The sign "Swan with Two Necks" is generally accepted as being a corruption of "Swan with Two Nicks," a nick being the distinctive mark placed on the beaks of cygnets preserved in those days in the upper reaches of the Thames by the Crown and by the Dyers' and Vintners' Companies.

Matthew Pickford was succeeded by Thomas and James Pickford, whose flying wagons left the Castle Inn, Wood Street, London, at four o'clock. They 'flew' to Manchester at a daily average of about forty miles This service ran three days each week in each direction, and the wagons called at several towns on the way. Their introduction resulted in the development of a considerable traffic in light goods.

[1] The idea was perpetuated in the use of the word 'fly' for a four-wheeled cab—in its time one of the slowest methods of wheeled transport.

ere also caravans of wagons, which trave
: than the express flying wagons, leaving
for the towns in the North. Later, when t
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lped considerably in the transport of fc

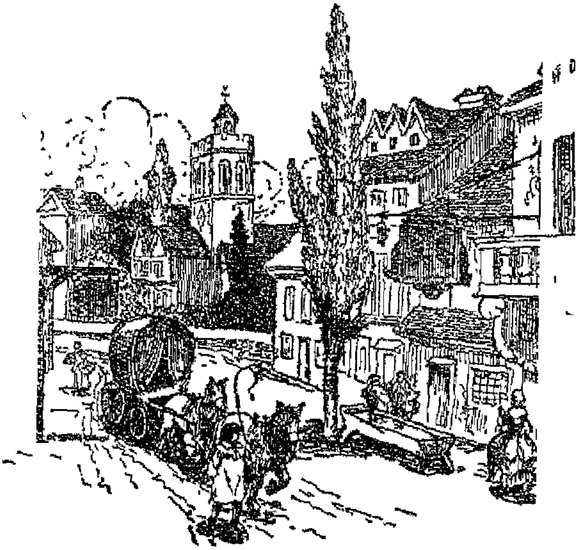


FIG. 17. CARRIER'S WAGON OF 1760 AT ISLINGTON

ce, they brought herrings to inland tow
to London, for sale at a much cheaper pr
ossible in the days of the pack-horse train
as considerable friction between owners
ns and those who were charged with the r
The great weight of the vehicles and their
kly destroyed the road surface, and the ma
that it was brought before Parliament. A
to increase the width of wheel tyres at

inches,[1] in order to reduce their effect on the soft roads, where the wheels caused ruts over a foot deep. Parliament endeavoured to promote the use of broad wheels by exempting wagons so fitted from turnpike tolls and by imposing fines upon the owners of the wagons with narrow wheels. It was regarded as an unfair hardship that wagoners should have to fit broad wheels—they did not see why they should be compelled to safeguard the road surfaces to make easy the passage of pleasure carriages—and as a consequence the Government regulations were evaded on every possible occasion.

Coaches differed from the earlier vehicles in that their bodies were suspended from posts or supports. Also, they were covered with a roof that was not a canopy but part of the bodywork. It is not known in which country coaches were first used, credit for their invention having been claimed by Spain, Italy, and France, as well as other countries.

In England, in the latter part of the sixteenth century, every pleasure carriage was known as a 'coach.' John Taylor, the waterman-poet, writing in 1623, stated that

> in the year 1564 one William Boomen, a Dutchman, brought first the use of coaches hither and said Boomen was Queen Elizabeth's coachman. A coach was a strange monster in those dayes, and the sight of them put both horse and man to amazement: some said it was a great crab-shell brought out of China, and some imagined it to be one of the Pagan temples in which the cannibals adore the devil!

He added:

> The mischiefs that have been done by them are not to be numbered, as breaking of legges and armes, overthrowing downe hills, over bridges, running over children, lame and old people.

[1] It was even suggested that tyres should be made 16 inches in width, it being pointed out that tyres of this size would serve to roll the roads flat! In a work by Daniel Bourne, dated 1763, is shown a design for a wagon with four wheels arranged so that the track of the front wheels runs inside the track of the rear wheels. As each of the wheels has a tyre 14 inches in width the wagon was expected to act as a roller over 5 feet of road as it passed along on its journey!

An *old picture* (Fig. 18) *shows* Queen Elizabeth on h
y to open Parliament on April 2, 1571. This was the fir

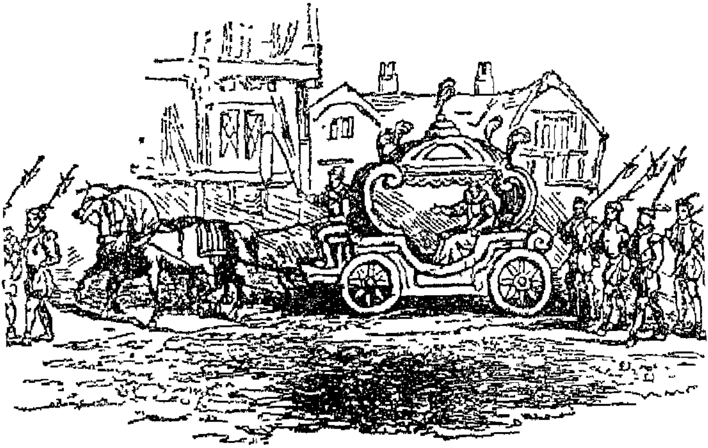
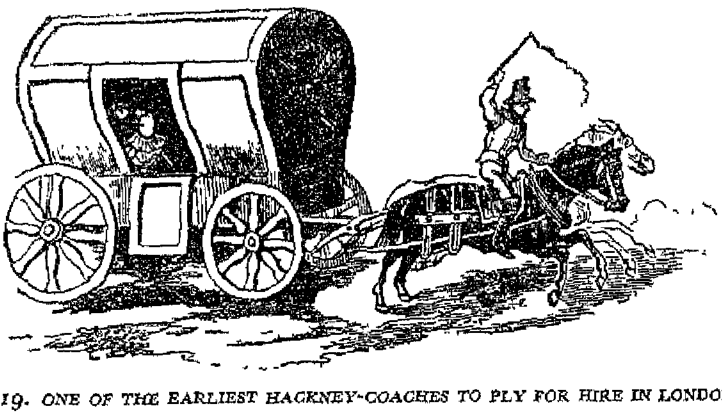


FIG 18 QUEEN ELIZABETH'S STATE COACH



19. ONE OF THE EARLIEST HACKNEY-COACHES TO PLY FOR HIRE IN LONDON

asion on which a *state* coach was used by a *sovereign* o
gland. The coach was the only vehicle in the processio
r the Queen's retinue rode on horseback—and it wa

a pair of horses with trappings of crimson velvet rıven by Boomen, the Queen's coachman

A HACKNEY-COACHMAN OF CHARLES II's TIME

of his horses, and was equipped with a He carried hammer and nails so that repairs' could be carried out expedi-

In the reign of Elizabeth an attempt was made to enact a "Bill to restrain the excessive use of coaches within this realm of England," but it was rejected on the second reading. In 1659 the popular nickname for coaches among Londoners was 'hell-carts.'

The antiquary Stow tells us that the coach was introduced into England by Henry Manners, second Earl of Rutland, who caused one Walter Ripon to build him a carriage, probably from a Dutch pattern. No entry in the family account-books can be found to confirm this statement, but in 1587, when the fourth Earl was holder of the title, there is an entry for "Coach, a newe, bought in London" By this date, however, most bility and many wealthy commoners owned coaches, rprising tradesmen hired their carriages out by the e number of these hired carriages steadily increased, they became known as 'hackney-coaches.'

t hackney-coaches remained in the owners' yards t for, but in 1633 a Captain Bailey used a regular

stand at the Maypole in the Strand for his four coaches, an innovation which seems to have met with general approval Lord Stafford wrote: "Everybody is much pleased with it, for whereas before coaches could be had but at great rate, now a man may have one much cheaper." Apparently the hiring of these coaches was peculiar to London, for Fynes Moryson, writing in 1617, tells us that "coaches are not to be hired anywhere but in London. For a day's journey a coach with two horses is let for about 10s a day or 15s. with three horses, the coachmen finding the horses' feed."

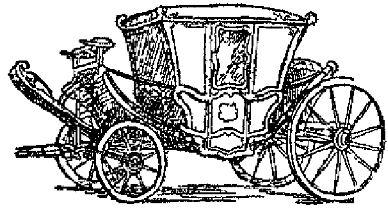


FIG 21 A COACH OF 1740

Hackney-coaches soon became so popular that John Taylor, the poet already mentioned, in a pamphlet, *The World run on Wheels*, bewailed their introduction, complaining that when the Court was at Whitehall the watermen lost 500 fares a day. Although at first the number licensed was restricted (to fifty in 1625), they continued to increase in numbers in spite of the opposition of the King and the Court, who thought they would break up the roads.

Hackney-coaches were often used during the Plague to carry sufferers to the pest-house, and Defoe, in his *Journal of the Plague Year*, tells us of an order (among others) issued by the Lord Mayor concerning the use of hackney-coaches. This was to the effect

> that care be taken of hackney-coachmen, that they may not (as some of them have been observed to do) after carrying infected persons to the pest-house and other places, be admitted to common use till their coaches be well aired, and have stood unemployed by the space of five or six days after such service.

In 1672 there was an agitation against the coaches, organized by certain "inne-holders, sadlers, cordwayners, sword-cutlers,

termen," and others of London, who fancied themselves ured by the innovation. Despite this opposition they conued to find favour until the end of the eighteenth century, which time the vehicles had become very much larger eir size may be judged from the fact that two boys who re settling an argument with their fists, having attracted the ention of a member of the newly formed police force, were hed into a near-by coach and told to fight it out there!

FIG 22 A STATE COACH OF THE EIGHTEENTH CENTURY

ckney-coaches were greatly in favour with the young llants, and many were the wild pranks they played at the pense of the coachmen, who, however, seem to have enjoyed e jokes more often than not. It is recorded that on one casion a hackney-coach was called to the British Coffeeouse in Cockspur Street to take up the Prince of Wales, afterrds George IV. His Royal Highness insisted on driving mself, and the coachman on being asked his opinion of his re's driving replied: "The Prince isn't such a bad driver, it he didn't take the crossings and corners careful enough for regular jarvie!"

Travelling 'post' seems to have originated with the Romans, 'ho established a system of letting out public vehicles for hire

during the time of the Emperors Augustus and Tiberius The vehicles were stabled at inns or post-houses, separated by distances of five or six miles and situated on the great main roads of Italy, and also on many of the Roman roads in Europe and Asia At each post-house some twenty or thirty horses were kept in readiness for hiring. Although the main purpose of these post-houses was to assist in the carrying of messages, their services were found to be so much in demand that additional horses and vehicles became necessary for the use of travellers. The chief vehicles used were the *essedum*, or two-wheeled chariot, the *cisium*, or gig, and the *rhedum*, or four-wheeled wagon, drawn by four or six horses or mules. Some idea of the speed at which these public vehicles travelled is gathered from the fact that Cesarius, a magistrate in the time of the Emperor Theodosius, posted from Antioch to Constantinople—a distance of 665 miles—in six days, thus averaging about six miles an hour.

Travelling by post was common in France in 1664, and was introduced into England in 1743 by John Trull, who obtained a patent for hiring carriages for cross-country work. These carriages, known as 'post-chaises,' generally were drawn by one horse in a pair of shafts. At first they had two wheels, and at the front a door that was hinged at the bottom; there was a window on each side. Later four wheels and two or more horses were used, a postillion riding on one horse of each pair. The body was larger, and was fitted with a movable hood or 'calash,' arranged to open or close as desired. Horses were changed at the end of each stage, relays being kept at post-houses The first organized relay was instituted between London and York (in 1650–53) by John Hill. The post-chaise became very popular, and was seen in all parts of the country. Mentioned in all forms of literature of the middle of the eighteenth century, it was the fast travelling carriage of the eighteenth and early nineteenth centuries.

Hackney-carriages remained in use until superseded by the

more convenient 'cab,' which derives its name from an abbreviation of the French word *cabriolet*, a hooded gig on two wheels. Cabs were introduced into Paris about the middle of the seventeenth century, and were known there as *cabriolets de place* The first cabs in Paris were those of Nicholas Sauvage, who lived at the sign of Saint-Fiacre, and so public carriages in France are to-day called *fiacres*. Cabriolets—graceful single-horsed carriages—were introduced into London early in the nineteenth century, and in 1823 licences were granted for twelve to ply for hire. A newspaper of April 23 of that year states "that cabriolets were, in honour of his Majesty's birthday, introduced to the public this morning. They are furnished with a book of fares, which are one-third less than the hackney-coaches." An illustration of one of these first cabriolets shows a curious vehicle running on two wheels, with a hood and curtains in front for the protection of the passenger in bad weather. The driver sat on a small seat at the side of the passenger.

An objection to the hackney-carriage was that if a single person hired one the fare was as much as if four persons rode in it They had a monopoly for carrying passengers in London, and consequently there was at first some opposition to the introduction of cabs, and it was some time before they were successful. In 1805 nine cabriolets were licensed, however, and started to ply for hire, but only in certain areas. In 1823 twelve more were built, and by 1830 over a hundred and fifty were plying for hire in London. They carried two passengers, the driver sitting beside them, but partitioned off The body was fitted with a collapsible hood, and a 'knee-flap' afforded protection to the passengers in bad weather.

Several experiments were made in their design, one (in 1834) by Joseph Aloysius Hansom, the architect of Birmingham Town Hall The body was "almost square and hung in the centre of a square frame," and the driver sat on a small seat on the roof, the doors being in front. The wheels were extra-

ordinarily large—7 feet 6 inches in diameter—being slightly higher than the vehicle itself This pioneer vehicle never plied for hire, and many alterations were made to the design before the final and familiar type was evolved. A company was formed to purchase the invention for £10,000, but of this sum Hansom obtained only £300, the balance being devoted to perfecting the cabs already plying for hire An improved form of hansom, introduced by John Chapman, became a popular vehicle for hire, until superseded by the taxi-cab during the period 1905–12. It resembled the cabriolet, had seating for two passengers, with folding flaps or doors, and windows that completely closed up the front when desired. The driver's seat was high up in the rear, communication between the driver and passengers being effected by a trap-door in the roof.

About this time the earlier two-wheeled cabs were stated to be "a source of acknowledged disgrace, of many alarming accidents, and of lamentable loss of life." A company was formed to provide "a cheap, expeditious, safe, and commodious mode of conveyance, in lieu of the present disgraceful and ill-conducted cabriolets" The first four-wheeled cabs appeared in London in 1836, although ten years earlier similar vehicles had been plying for hire in Liverpool and Birmingham In the first cabs of this type—known as the 'covered cab'—there was accommodation for two passengers inside and a third on the box with the driver, the doors being at the sides Later the design was improved and it ultimately resulted in the 'Clarence,' more commonly known as the 'growler,' which became the vehicle of the elderly. At first hansoms were regarded as suitable only for the less respectable section of the people, a character that persisted partially until comparatively recently. In Victorian days no 'lady who was a lady' would be seen riding in a hansom Many of the old-time cab-drivers—or 'cabbies,' as they were familiarly called—were real 'characters,' and nearly all were known by nick-

names. They were recruited from all ranks of society, even including among their number professional and army men who had fallen on bad times.

Lord Chancellor Brougham was very interested in the cabriolets, and in 1838 ordered one for his private use. This vehicle—the first 'brougham' and the forerunner of a multitude of private four-wheeled closed carriages to be drawn by one horse—is now in the Science Museum, South Kensington. Its appearance in London caused a great sensation. Its original colour was light olive green, picked out with black, and the more noticeable peculiarities of the body are a projecting case and a guard-board behind. Such a case was at that time provided on all coaches, and was originally intended for holding swords, which were thus accessible from inside The guard-board, known as the 'opera board,' was placed in position when the carriage was likely to be used in crowded traffic, to guard against the serious danger of 'poling' by a following carriage

There were many other developments of the light carriages —for example, the Victoria, phaeton, landau, wagonette, etc —but these were mainly for private use.

To return for a moment to the development of the coach During the seventeenth century there were many changes in design in coaches and carriages—not only in England, but also on the Continent. A popular carriage at this time was the berlin, first made in 1660. It differed in principle from earlier carriages in having two perches instead of a single pole. Between these two perches, from the front transom to the hind axlebed, were two strong leather braces with jacks or small windlasses, to wind them up tighter if they stretched. The leather braces allowed the body to ride vertically, instead of swinging horizontally, as in the earlier carriages The double perch was subsequently used for many carriages both in England and abroad, and it remained in use until about 1810.

During the seventeenth century both public and private

coaches were built more compactly and had a more graceful appearance. Complete doors and glass windows were introduced, the latter probably first being used in Spain, where in 1631 an Infanta of Spain is stated to have traversed Carinthia in "a glass carriage in which no more than two persons could sit" The first English vehicle to be fitted with glass windows appears to date from 1661 and to have been a coach belonging to the Duke of York.

These improvements resulted in the development of a more comfortable vehicle, and one that would at the same time afford greater safety and speedier means of travelling. It has been suggested that the popularity of the sedan chair had an important effect upon the design of the form of the coach, for after its introduction into this country the body of the coach gradually assumed a shape more closely resembling that of the chair.

By far the most important development, however, was the invention of the elliptical spring patented in 1804 by Obadiah Elliott, a coachmaker of Lambeth This type of spring, which may be seen on many modern vehicles, eliminated the severe jolting that had previously caused great discomfort and was largely the cause of the limitations in the general use of carriages Elliott's invention was important not merely for the greater comfort that it afforded, but also because it made possible a complete change in design of the coach, owing to the fact that the springs could rest on the axle. It was thus possible to dispense with the heavy combined wood and iron perch and cross-beds that had previously been used The Society of Arts awarded their gold medal to Elliott, who received large orders for his patent carriage Later it was found that on rough roads elliptical springs did not give sufficient ease in riding, but by adding horizontal springs below the C springs, carriages were rendered more serviceable and travelled more comfortably.

From a communication written by a Mr Edgeworth in 1808

it appears that springs were not generally applied to stage-coaches even at that date. Before the application of springs to these coaches the proprietors of the Shrewsbury coach paid, in the course of a year, no less than £600 for goods damaged by jolting in the carriage! "I recollect when, before springs were put to stage-coaches, one could not send a trunk fifty miles without having it knocked to pieces." [1]

The invention of rubber tyres helped even further to bring carriages to their highest efficiency. The resilient tyre is by no means a modern idea, for the device was known to and used by the ancient Egyptians. They seem, however, to have been unknown in Britain until 1845, when the pneumatic tyre was invented by R. W. Thomson. These tyres were made and tried on ordinary carriages, and were found not only capable of absorbing vibration and shocks, but also of greatly reducing the tractive effort necessary to draw a carriage, especially on rough roads. The invention was not proceeded with, however, probably on account of the imperfect construction and because the advantages at low speeds were not sufficient to warrant the cost of the large tyres found necessary. When the bicycle tyre was brought out the idea of a pneumatic tyre for carriages was revived and repatented (in 1888) by J. B. Dunlop. Solid rubber tyres were used for carriages about the time that the pneumatic tyres were first tried (1845), but they did not become common until after their application to the bicycle (about 1870).

[1] *Testimony of George Orr* (1809)

CHAPTER V

THE COACH

STAGE-COACHES were first used about 1640, and although (as we shall see later) they gave place to mail-coaches, they remained in use for practically two centuries. In some respects the stage-coaches resembled the earlier hackney-coaches, although generally they were of larger size. A writer of the period tells us of their

> admirable commodiousness both for men and women, to travel from London to the principal towns in the country, that the like hath not been known in the world, and that is by stagecoaches, wherein one may be transported to any place, sheltered from foul weather and foul ways, free from endangering of one's health and one's body by hard jogging or over-violent motion on horseback; and this not only at the low price of about a shilling for every five miles, but with such velocity and speed in an hour as the foreign post can make but in one day [1]

It was not every one who found the coaches so admirable, however, and they were not without opponents, just as was the case later with canals, railways, and motor-cars. Many curious arguments were brought forward by interested parties in favour of their suppression as a national evil. It was argued, for instance, that the coaches—the 'hell-carts'—destroyed the breed of good horses; that they were prejudicial to the strength of the nation, by making men careless of horsemanship; that they hindered the breed of watermen, and thereby deprived the Navy of good seamen, and that they lessened the King's revenues

Despite all arguments, however, the stage-coach held its

[1] Edward Chamberlaine, *Angliæ Notitia, or The Present State of Great Britain* (1649)

place, fulfilling the requirements of the times. When later it developed into the mail-coach it became the generally recognized means of travel, paving the way for the railways that were to follow.

In the first coaches the body was suspended from four posts, the coachmen sitting on a bar between the front posts. They accommodated six or eight passengers, the luggage being carried in a great basket, strapped between the huge wheels at the rear. Here also the outside passengers sat up to their knees in straw The inside passengers were protected from the weather by leather curtains until 1680, when glass windows were introduced, the vehicles so fitted being known as 'glass-coaches'

At first the coaches ran only in the daytime, and for many years only during the summer.[1]

Although in 1662 there were only six stage-coaches, the number soon increased Seven years later there were coaches running regularly from London to York, Chester to Exeter, each carrying six inside passengers The rate of travel was slow—the first coach between York and Leeds required eight hours to cover the twenty-four miles between the two places. The road was so bad that it was usual for the passengers to have to get out and walk a great part of the way The rate of travelling showed but little improvement in twenty years

The coaches were drawn by four horses, and each team hauled the coach for a 'stage'; hence their name. On arrival at the end of the first stage the horses were unharnessed and another team yoked up. They carried the coach on its next stage, at the end of which they were replaced, in turn, by a new team. When the teams had been fed and rested they worked the returning coach over the same stage in the reverse direction. For the London-Exeter coach forty horses were required to be kept on the road, so that in this case, roughly speaking, each stage consisted of about twenty miles

[1] Day and night coaches commenced about 1800.

stage-coaches travelled daily to places within
ty miles of London, returning on the following
again travelled to places within ten miles or so
l returned the same day. In 1706 a coach ran
to York three times a week (four days were still
he journey), each passenger being allowed free
a weight of 14 pounds, above which the charge
und. In 1742 a coach left London at 7 A.M. for
reaching High Wycombe at five o'clock in the

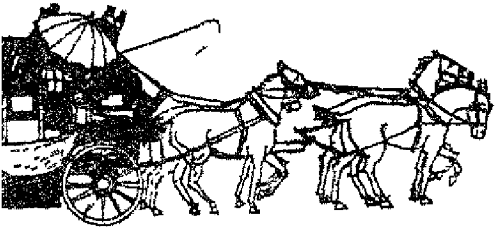


FIG. 23 A STAGE-COACH

med there overnight and proceeded to Oxford
ng day In 1751 a coach ran to Dover from
ng at Canterbury the same night and reaching
ext day. It commenced its return journey to
me afternoon. From the advertisement of this
states that there is a conveniency behind the
age and outside passengers, we gather that even
te it was not usual to carry passengers on the

"Flying Coach" commenced to run from Man-
ndon. The advertisement of it stated: "How-
it may appear, this coach will actually arrive in
r days and a half after leaving Manchester." It
that we have the first reliable account of a stage-
d on springs. An old advertisement tells us
inburgh Stage Coach, for the better accommo-

dation of passengers, will be altered to a new genteel two-end glass coach machine, being on steel springs, exceeding light and easy to go in ten days to London in summer and twelve in winter every other Tuesday."

In 1757 a coach ran from Liverpool to London in three days, which was a considerable improvement on the four and a half days required by the Manchester "Flying Coach" of only three years earlier. Sheffield and Leeds followed the example, and 'speedy coaches' were set up.

As there was a growing tendency to overcrowding, the number of passengers was restricted by Parliament in 1785, and again in 1790. The necessity for these restrictions is mentioned in the *Annual Register* for September 20, 1770, where it was stated:

> It were greatly to be wished the stage-coaches were put under some regulations as to the number of persons and quantity of baggage Thirty-four persons were in and about the Hertford Coach this day when it broke down by one of the braces giving way.

In 1806 a Committee appointed to examine—among other things—the Act limiting the number of passengers to be carried by stage-coaches reported that the laws for the security of the public and for the preservation of the roads had been grossly evaded,

> insomuch that, instead of six (the number allowed by law), twenty passengers and more were often carried on the outside of stage-coaches It is not unusual to see ten on the roof, three on the box, besides the driver, four behind on what is called the gamon board, and six on the dickey or chair; in all, often above thrice the number intended to be allowed

The consequence of this overloading was that accidents were

> continually happening in one part of the kingdom or another; and indeed, scarce a week passes without some of those carriages breaking down, and often killing the unfortunate passengers

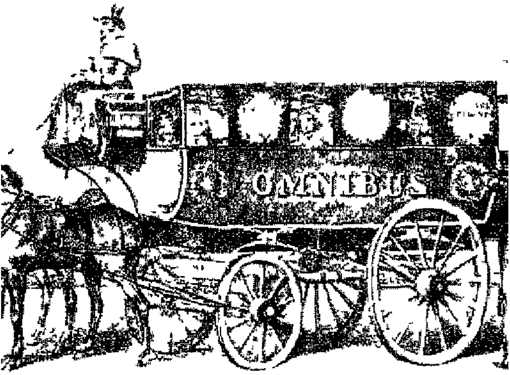
Every precaution seems to have been taken against ordinary accidents, for each day before the start the coaches were examined from the front of the pole to the back of the boot—wheels, axles, linch-pins, springs, and even the glass in the windows. Every part was kept beautifully clean, and each horse was groomed as carefully as though it belonged to the stud of a nobleman. On special occasions, such as when the coach was carrying to ten thousand homes the news of some national victory, the coach and the horses would be decorated with laurels, oak-leaves, flowers, or ribbons The uniforms of the coachman and guard were also decorated, and we can well imagine the excitement of such an occasion, as the coach prepared to leave The passengers having taken their seats, "the noise of the lids locked down in the mail-bags smote the ear, the trampling of high-bred horses, as they bounded off, and the thundering of wheels were soon lost amid the shouts of hosts of spectators." There is, however, another side to the picture. Stories are told of dreary waitings at the roadside in the early hours of wintry mornings for coaches which, when at last they did arrive, were full; of how passengers on the coaches could scarcely keep awake and dare not go to sleep; of roads so "infamously bad that the whole range of language could not describe them." Then there were the exciting perils of a "race betwixt two stage-coaches in which the lives of thirty or forty distressed and helpless individuals were at the mercy of the two drunken drivers." The drivers, indeed, seem to have been given a bad name by everybody, for they were said to be "seldom sober, never civil, and always late!"

Notwithstanding the disadvantages, some people seem to have thoroughly enjoyed travelling by coach. Dr Johnson, for instance, wrote that the most pleasing thing in existence was to travel in a mail-coach at the rate of six miles an hour. Many others wrote in glowing terms of the delights of travelling in the "coaching days of old." Whatever anyone may say,

however, it cannot have been a very delightful experience to be perched on the outside of a coach for perhaps twenty hours, exposed to all weathers and trying in vain to find a comfortable position; to endure long and wretched winter nights, half starved with cold and hunger, sitting first with the face and then with the back to the wind or rain. Often in winter the passengers were unable to get down without assistance, and even then, nearly frozen to death, they could only be got down in the bent positions into which they had stiffened! No doubt such an experience was not anticipated without anxiety by many whose business required them to travel Nor was it more agreeable inside the coach, for the space was very small, and passengers were packed so tightly that they were unable to change their positions even when their limbs became cramped

At all times and especially in bad weather, and in winter, a coach journey was a particularly hazardous undertaking, and many were the thrilling adventures encountered by the travellers Highwaymen, collisions with other horse-drawn vehicles, obstructions in the roadway, and snowstorms that often meant isolation—these were the principal dangers to which passengers were exposed. Sometimes the horses would stumble over a donkey or other animal that had taken up its night quarters in the middle of the road and there made its bed! Fogs considerably hampered progress, interrupting the coach services, and being attended with alarming and often dangerous experiences. Snow was the greatest enemy, however, and often the coach was snowed up more than once on the same night

At first stage-coaches generally travelled about six miles an hour, but later, at the request of the public and by the competition of the rival stage-coach proprietors, were speeded up By 1784 a speed of eight miles an hour had become general. In attaining a higher rate of travel coaches were greatly helped by the use of better horses and by the improved condition



4 SHILLIBEER'S OMNIBUS (1829)

From an engraving in the Guildhall Library

MN KA N AT R N R 860

om a print in k seum

1 A KNIFEBOARD OMNIBUS OF 1887

of the roads Towards the end of the eighteenth century a speedier means of transport was introduced in the form of the mail-coach, primarily introduced as a quick and cheap means of carrying letters.

Until the seventeenth century letters and dispatches were forwarded by 'post-masters' by private arrangement, the post-master's business actually being, of course, to furnish post-horses to travellers. In 1635 Charles I opened a letter-office for England and Scotland, but this service extended only to a few of the principal roads, and the times of dispatch were uncertain. In 1649, in the time of the Commonwealth, letters were forwarded to all parts of the kingdom every week. Although Cromwell further improved the service seven years later, this post-office was far from satisfactory, the mails being sent by post-boys who rode either in small carts or on horseback. Not only was this form of transport very slow—the rate of travel was about 3½ miles an hour—but more often than not the mail was robbed. The post-boys had no means of defending themselves, and, indeed, they themselves were often in league with the robbers Things gradually became worse, until the post was almost the slowest conveyance in the country. Whereas before 1784 the coach accomplished the journey from London to Bath in seventeen hours, the post required forty hours for the same journey.

In 1784 John Palmer, manager of the Bath Theatre, proposed to convey letters with greater speed and safety by contracting with the proprietors of the stage-coaches to carry the mail, binding them to perform the journey in a specified time and to carry an armed guard.

Palmer further suggested that the times at which the coaches left country towns should be so regulated that they should arrive in London at an early hour each morning, and they should all leave London at the same hour every evening. This suggestion met with fierce opposition from officials and from Parliament It was declared to be impossible to bring letters

from Bath to London, a distance of 108 miles, in 18 hours, involving a speed of transport of six miles an hour Experiments were made, however, and after a struggle of two years Palmer's mail-coaches were allowed to carry the mails. The first mail-coach left the Swan with Two Necks, Lad Lane, London, for Bristol on August 2, 1784.

Palmer was a man of great organizing ability, and before the end of the century his coaches were running on practically every highroad. By 1835 there were 700 of his coaches on the roads of Great Britain and Ireland, their use only ceasing about 1838, when they were superseded by the railways. The services were organized in the form of a connected chain from one end of the country to the other—from Falmouth in Cornwall to Thurso in Caithness, which, *via* London, covered a distance of over a thousand miles. By this means it was possible for a letter to reach almost any part of the country in a comparatively short time.

Palmer's first coaches were similar to the existing stage-coaches, were drawn by four horses, and ran at an average speed of about six miles an hour In addition to the mail, they could take six persons, but they carried no luggage About 1800 they were improved and constructed to carry four inside and four outside passengers, and to travel at seven or eight miles an hour Even this speed was considered sufficiently excessive, however, to create alarm in certain quarters. A Postmaster-General's minute, issued in 1791, directed that, as far as possible, all persons should avoid sending cash by post, "partly from the prejudice it does the coin by the friction it occasions from the great expedition with which it is conveyed, and especially as the cash is likely to fall out of the letter through jolting." Apprehensions of the speed of the coaches were not confined to postal officials, however, for Lord Campbell, Attorney-General of England, frequently emphasized the danger of 'speeding' He even cited instances in which passengers had died of apoplexy, induced by

the rapidity of mail-coach travelling! Despite these critics the speed of the coaches increased, until by 1836 there were several that travelled at an average speed of about ten miles an hour. In this year the time allowed for the journey from Edinburgh to London (400 miles) was 45½ hours; on the return journey the time was cut to 42½ hours. From London to York (197 miles) 20 hours were allowed, London to Manchester (185 miles) 19 hours; London to Exeter (176 miles) 19 hours, London to Holyhead (259 miles) 27 hours; and London to Devonport (216 miles) 21 hours

CHAPTER VI

THE HORSE-DRAWN OMNIBUS

OMNIBUS is a Latin word meaning 'for all,' and was first applied to the vehicle now known by this name to denote the universal accommodation it offered

At the beginning of the nineteenth century several experiments with vehicles of the omnibus class were made in this country, one of the novelties of the period being a vehicle with six wheels drawn by four horses. The omnibuses were so much like hearses, however, that people would not ride in them.

In 1829 Shillibeer's omnibuses began to ply for hire from the Yorkshire Stingo, Paddington, along the New Road (as Marylebone, Euston, and Pentonville Roads were then known) to the Bank of England. The fare of one shilling for the whole distance and sixpence for half the distance compared favourably with the fare of three shillings inside and two shillings outside charged by the proprietors of the three or four short-stage coaches that previously served the same route

Because of the economy in fares, and because also they were much quicker (their predecessors had taken three hours for the journey from Paddington to the Bank !), the new omnibuses became very popular They made twelve journeys a day and generally were full, and their takings averaged £100 a week Soon their number was increased until there was an hourly service on some fifty routes in London, and ultimately they ran from one end of the metropolis to the other

Some of the advantages of the omnibus were thus described by a writer of the time:

THE HORSE-DRAWN OMNIBUS

In an *Omnibus* there can be no coquetting about who shall ride backwards, because you *must* all ride *sideways*. In an *Omnibus* there is little chance of disagreement about opening or shutting of windows, because as the windows are all behind you, nobody but a *cold-proof* passenger would venture to open the one against which he sits—and such passengers are very rare animals indeed. In an *Omnibus*, therefore, everybody is sure to be quite warm enough, and if anybody should be too warm, he is at liberty to quit at a moment's notice, whenever he pleases. In an *Omnibus* there is no delay in taking up and setting down, no calling at booking offices; no twenty-minutes-waiting at "the Cellar"; no compulsive *cad*-cramming In an *Omnibus* you may ride as far for *sixpence* as you can in a coach for eighteen-pence. In an *Omnibus* there is plenty of stretching room for the longest of legs, without knee-packing—this is a great desideratum Lastly, an *Omnibus* like most of our modern farces, is of *French* origin; and, therefore, must be highly appreciated by all English men and women who have any pretension to taste [1]

The poor appreciated the new form of transport, too:

As to comforts of Omnibuses, we need say but little. That they are an immense boon to the public no one can deny People are apt to grumble, but it is not clear that the ordinary omnibus for ordinary work can be much improved. The other day—it was a Saturday—I chanced to ride from the Exchange to Old Ford—it was a cheap ride—for twopence and back again, and it was perfectly amazing, the number of poor women with parcels, the number of artizans coming home from work, of little children on errands that used the omnibus, and returning we were full inside and out, and I felt, as I never felt before, what a boon a cheap omnibus was to the community at large.[2]

Shillibeer introduced a remarkable innovation in that he rovided newspapers and magazines free of charge for the use f passengers In passing we may mention that even this onsideration for passengers subsequently was exceeded by

[1] *The Morning Herald*, October 10, 1829

[2] News-cutting (1873) in the Hartridge Collection, Guildhall Library.

another omnibus proprietor, Mr Cloud, who ran a service between the White Horse, Haymarket, and Chelsea and Hammersmith Instead of newspapers and periodicals he supplied his passengers with books by popular authors of the day. Each of his omnibuses was fitted with a well-stocked bookcase, and, as at that time books were expensive luxuries, it is scarcely surprising to learn that many people made the journey to Hammersmith and back for the express purpose of reading the latest work by their favourite author! The persistent thefts of the books caused the omnibus libraries eventually to be discontinued

The success of Shillibeer's omnibuses stimulated imitation by rivals. The Post Office were the first in the field with four vehicles, built similar to the original omnibus and called 'accelerators.' On September 23, 1829, these started from behind the General Post Office, each carrying twelve or thirteen letter-carriers, who were put down at various points to commence delivery of their letters. Soon after, Shillibeer's brother-in-law commenced an omnibus service in the Caledonian Road, his vehicles being known as Caledonians They were subsequently taken over by Wilson, a famous omnibus proprietor of Islington, who ran buses known as 'Favourites,' and whose business was later acquired by the London General Omnibus Company.

In 1832 Shillibeer took into partnership a Mr Marton, a publican of Southwell. The partnership lasted only two years, and when it was dissolved Marton took the New Road buses as his share. He was no more successful alone than he had been in partnership, however, and ultimately was reduced to working as a conductor. On being discharged from this position for drunkenness he committed suicide.

In addition to inciting these competitive lines the omnibuses started the coaching interests into rivalry. Naturally the proprietors of the stage-coaches disliked Shillibeer's competition and commenced to wage war on him, endeavouring by every

means in their power to rob him of passengers They substantially reduced their fares and began to run a service alongside his omnibuses on each journey, and did not hesitate even to paint the name 'Shillibeer' on their vehicles. They endeavoured to incite the public against Shillibeer, declaring that, as he was a Frenchman, he should not be allowed to run his foreign vehicles in England. The aristocratic residents of Paddington Green—then an exclusive suburb—objected to the omnibuses and petitioned the authorities against them. When the petition proved unsuccessful they vowed that Paddington Green as a select residental district was doomed—forebodings which, judging by the state of things to-day, have been more than justified, although not because of the omnibuses!

In addition to these pirates and imitators there were others who endeavoured to secure the business by enterprise. For instance, one proprietor of rival buses fixed wooden rings to the arms of the drivers, cords being attached to the rings for the use of the passengers or conductors in signalling 'stop'. If a passenger pulled the cord attached to the ring on the driver's left arm he would stop on the near side, and in the case of a right-arm pull he would stop on the off side This was certainly an innovation, for in the ordinary buses if a conductor desired the driver to stop or proceed he simply shouted his instructions or slammed the door Bells were not introduced until a much later period.

Shillibeer struggled gallantly against the opposing forces, but at length the combination of hostile interests compelled him (in 1834) to abandon the Paddington Road business. He started a service between London, Greenwich, and Woolwich, but this too he was obliged to abandon owing to financial difficulties due to competition He next devised a patent carriage that combined the purposes of hearse and mourning-coach, but, finding that the undertakers would not use it because it threatened to reduce their profits, he commenced

business himself as an undertaker. He brought about sweeping revisions in the charges of funeral-coach proprictors, which until then had been extortionate. Soon Shillibeer's funeral-coaches were as well known as his omnibuses had been. It was because of this that the word 'omnibus' came into general use, for hitherto these vehicles had generally been known as 'Shillibeers.' When Shillibeer's funeral-coaches became so well known the travelling public did not like the funereal association of the coach in which they were riding, and so these vehicles became generally known as 'omnibuses.' Thus it was that Shillibeer did not retain the distinction of Brougham and Hansom in having a popular vehicle named after him. He died at Brighton on August 22, 1866, aged sixty-nine, and is buried in the churchyard at Chigwell.

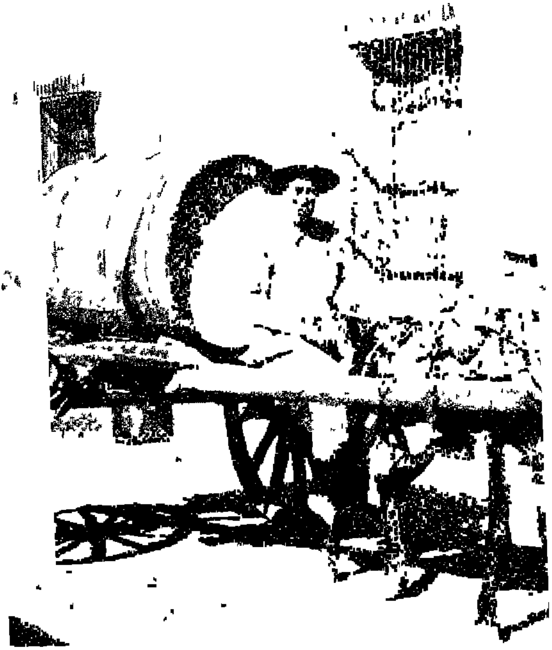
The horse-omnibus had to meet some competition from the steam carriages of Gurney and Hancock, with which we deal later (see Chapter XI). These steam carriages were popular while they were a novelty, but ultimately they were withdrawn, leaving the horse-drawn vehicle in sole possession By 1837 horse-omnibuses were running from Blackheath to Charing Cross; Chelsea to Mile End; Piccadilly to Blackwall; Hampstead to the Bank; the Angel, Islington, to the Elephant and Castle; and Edgware Road to the Bank. There were also regular services to the City from Putney, Kew, Richmond, Deptford, Greenwich, Norwood, Dulwich, and many other suburbs. Most of the lines ran under a name—such as the Favourite, Eagle, Hope, Paragon, Atlas, Royal Blue, Times, etc

In the late thirties there were many complaints against the omnibuses and their drivers, who were often fined for furious driving. The conductors were not only uncivil, but at times even abusive, and because of their behaviour became known as 'cads.'

When Shillibeer left the Paddington Road, the proprietors began to quarrel amongst themselves and to oppose each other with the fiercest acrimony. The men they employed to drive

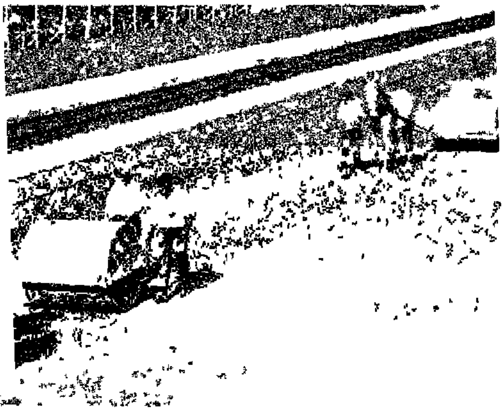
THE PONDEROUS AND SLOW-MOVING BUFFALO CART
seen in India to-day. Carts of this type have been in use there for ag

b A CAMEL-DRAWN WATER-CART IN ADEN



A PRIMITIVE METHOD STILL IN USE IN MEXICO

[illegible] water cart is a common sight in hundreds of Mexican [illegible]



[illegible]OUS FORM OF TRANSPORT—TOBACCO-ROLLERS [illegible]

AN[illegible] OT[illegible]ER [illegible]OU[illegible] [illegible]RN [illegible]

[illegible] Bal[illegible] and [illegible]

and receive the fares were coarse fellows, who used the foulest language, and performed the most reckless feats in driving and racing [1]

In 1855 the London General Omnibus Company was founded This company not only contributed greatly to the improvement in public transport, but its activities marked the beginning of a new era in transport. Few people are aware that the London General Omnibus Company was founded in Paris, but in 1855 a French company was formed to run omnibuses in London under the title of Compagnie Générale des Omnibus de Londres, the managers being well-known London omnibus proprietors The company first bought up the old-established business of Wilson (who ran the line of 'Favourites'), consisting of fifty omnibuses and 600 horses, and took over also the staff of 180 men On January 7, 1857, the first omnibuses to carry the name "London General Omnibus Company" left the yards at Islington The company rapidly extended, purchasing existing lines and starting new ones, so that by November 1857 they owned 600 omnibuses and 6200 horses, and operated sixty-six routes, carrying a million passengers a week. In the following year the French company was liquidated, a new company—the London General Omnibus Company, Ltd—taking over the business. A scheme of all-round improvement was introduced The 'knife-board' type of vehicle was ultimately replaced by the 'garden-seat' type,[2] the seats outside being similar to those later in use on the London motor-buses. Ladders, which in the earlier vehicles gave access to the roof, were replaced by stairways, from which time ladies were often seen riding outside.

In 1891 there was the famous omnibus strike. The men of the London General Omnibus Company came out owing to

[1] *Chambers's Edinburgh Journal*, June 14, 1845.

[2] Introduced by the London Road Car Company, established in 1880 and a formidable competitor of the L.G.O.C.

the introduction of the roll-ticket system,[1] which had been adopted previously by the London Road Car Company. The men opposed the innovation, some subsequently declaring that over and above their wages under the old system they had 'made' 8*s.* or 10*s.* a day, which they shared with the drivers In spite of an additional 2*s.* a day promised by the company, they came out on strike on May 7, the Road Car Company's men coming out in sympathy. London was without omnibuses until the strike was settled on May 14, the men ultimately accepting the Company's terms.

Although much of the omnibus traffic was ultimately lost—by the introduction of tramcars, of motor-buses (in 1899), and of the Central London Railway (in 1900), familiarly known as the 'Tube'—horse-buses continued to run until 1911 (see p. 163). The number of buses was continually increased to cope with the growth of traffic, and in 1905 there was an average of 1418 buses and 17,000 horses belonging to the London General Omnibus Company, while the Road Car Company owned 560 buses

We may here not inappropriately include a brief reference to street-trams—horse-drawn, steam, and electric—as distinct from the old 'tramways,' or 'tram-roads,' of the collieries, which are more correctly dealt with under the heading of railways (see p 115). The word 'tram' is probably derived from the fact that beams of timber were used for the rails. In certain parts of England these beams were called 'trams,' the origin of which is the Swedish word *tromm*, 'a log,' or German *tram*, 'a beam.' 'Tram' was also the name given to the shaft of a cart or carriage, which name may have been later applied to the whole vehicle. Either of these alternatives seems a more probable origin of the word than the suggested derivation from the name of James Outram, of Sheffield, who laid some of the early cast-iron tracks at collieries.

[1] This was unsatisfactory as a check on receipts, and it was not until the bell-punch system was introduced (in 1893) that an effective check was obtained.

The world's first street tramway for horse-drawn cars was opened in 1832 in New York, but was later abandoned Another tramway in 1852 was more successful, and three years later a tramway was opened in Philadelphia. The rails were of wrought iron, and the gauge was 4 feet 8½ inches. The first tramway in Europe was from Woodside Ferry to Birkenhead Park. In 1860 George Francis Train, an American, obtained permission from the Birkenhead Corporation to construct an experimental tramway in the town, and the line was opened for traffic on August 30 of that year. The success of this project encouraged Train to lay (in 1861) a track in London between the Marble Arch and Notting Hill Gate, but as a raised step-rail was used the track was considered an obstruction and had to be removed. The next track to be laid ran between Victoria Station and Kennington Gate About the same time tracks were laid in Staffordshire, where they were known as the "Street Railway." An early experimental line, laid at Liverpool soon after, had to be taken up, the step-rail being deemed a public nuisance.[1] There was no lack of opposition to tramways by horse- and carriage-owners, and, so far as Liverpool was concerned, it was not until 1865 that a practical scheme was brought forward for the construction of a tramway. Three years later the Liverpool Tramways Company, Ltd., was incorporated, and, as their first line proved popular, additional powers were obtained and further lines constructed. Liverpool, first to obtain the necessary powers, was followed by London, Glasgow, and Dublin. In 1875 Manchester laid its first tramway, which was worked by a private company until 1901, when the Corporation took over the lines and electrified them.

Cable tramways are those in which a moving cable in a conduit draws the car along, being gripped by an arm carried by

[1] The objections to the step-rail track were subsequently overcome when grooved rails were introduced, although these had the disadvantages of offering more resistance and of collecting dirt.

the car. These tramways were tried in 1873 at San Francisco, and in England in 1884 at Highgate Hill. Three years later they were introduced at Edinburgh, and remained in use until as recently as 1922, when they were replaced by the overhead electric system. Cable tramways fell into disuse because of their great cost of construction and slow speed. The working cost is low, and they are safe on steep inclines, but heavy traffic is required to recoup the initial outlay.

Steam trams were in use in America in 1859, and as early as 1872 there were over seventy miles of track at Buenos Aires[1] Steam was not used in Britain until 1871, however, when a line was opened at Leith—even though the Act for Mechanical Power, permitting the use of steam, was not passed until eight years later. Although steam cars gradually replaced horse-cars they were generally dirty, noisy, and uncomfortable, and towards the end of the nineteenth century they were replaced by electric cars.

The first experimental electric lines were laid in 1881 at Budapest, and in Ireland (from the Giant's Causeway to Portrush) in March 1883, and at Brighton Beach in August of the same year The first regular electric system was that of Blackpool, which was opened in October 1884. There have been three main types of electric systems: (1) the conduit, (2) the surface-contact, and (3) the overhead. In the conduit system a conductor carrying the current is placed in an underground conduit, having a narrow slot at the top through which the collecting shoe of the car passes. The Blackpool tramway was laid on the conduit system (portions of the old track may be seen to-day in some of the side streets), which was also the system used at Budapest and in some of the early American cities. There have been two types of conduit construction: (1) that in which the conduit is placed in the centre of the track, and (2) where it is placed underneath one of the track rails. The former type is used to-day by the London County Council,

[1] See *Engineering*, May 1872

and the latter system was in use at Bournemouth until replaced by the overhead electric. In the conduit system the great width of the conduit resulted in disturbing not only the road surface, but also gas and water mains, electric supply, and telephone cables. Imperfect drainage of the conduit also caused trouble, and to overcome this difficulty was a highly costly undertaking To-day this system is only used in certain parts of a few of the larger cities where overhead wires are impossible or undesirable. The only one in England is that in London, but there are others in Paris, Berlin, Brussels, Budapest, Bordeaux, Lyons, Vienna, and New York.

Many attempts were made to discover an alternative that would eliminate the high cost of the conduit system The most successful was the surface-contact system, in which current was supplied by an underground cable to a row of metal studs placed 10 to 15 feet apart, extending down the centre of the track and projecting half an inch above the surface of the roadway. These studs were 'alive' only when the car was passing over them, the pressure of a long contact bar depressing each stud in making contact with the live cable beneath. The surface-contact system has been used in this country at Wolverhampton, Lincoln, Torquay, and Mexborough, but no example now remains. Abroad the system has been tried at Paris, Tours, Monaco, and elsewhere. The system was rendered obsolete because of difficulty with the necessarily huge number of studs, or automatic switches, which could never be made absolutely reliable under all conditions

The introduction of the overhead trolley-system, now used generally throughout the world, opened up a new era for manufacturers of electrical plant and for the makers of rails, points, and crossings. The first overhead trolley-line was opened in 1889 in New York. The first in this country was that of Roundhay, Leeds, opened on January 8, 1892, the company being taken over two years later by the Leeds Cor-

poration, who reopened the track in July 1897. On New Year's Eve 1893 electric trams commenced to run in South Staffordshire, and in October 1895 at Bristol (from Old Market Street to Kingswood). Other early overhead electric tramways were Coventry (December 1895), Dublin-Kingstown-Dalkey, and also Hartlepool (May 1896)

In the overhead system the current is collected by a small grooved wheel carried at the end of a long trolley-arm, kept in contact with an overhead wire by strong springs. The overhead wire, which in the United Kingdom must be carried at a safe height of not less than 17 feet, is supported either by bracket-arms from a central standard or from a side standard, or by cross wires fixed to buildings on each side of the road. Current is generally supplied at 500 volts, and as the pressure falls as the distance from the generating station increases, large tramway systems distribute the current at 5000 volts to substations, where it is transformed to 500 volts for the overhead wire. On the car the current is controlled by a switch handle actuating a number of resistances, usually placed under the seats of the car. Generally there are two motors fitted to each car, one on the front and the other on the back axle.

At the present time tramways are in many places being abandoned in favour of motor-buses. The fixed track has obvious disadvantages, and the greater adaptability of the bus makes it much more suitable for modern needs. In some cases trackless trams are being used.

Trackless trams—electric trams without rails—are fitted with rubber-tyred wheels and run on the ordinary roadway They represent a compromise between the electric tram and the motor-bus, and draw current by means of a trolley-arm from an overhead wire. They have the advantage of being more adaptable on congested roads, for, within certain limits, they can be steered as motor-buses. In addition, there is no high first cost for laying the track and no track maintenance cost. Trackless trams were first installed in this country at

Aberdare, in Glamorgan, and also at Keighley, in Yorkshire, where a service from Ingrow Tram Terminus, Keighley, to Hebden Road, Haworth, was commenced on May 3, 1913 Further extensions to the service were made subsequently, and on August 20, 1924, trackless trams were substituted for the tramway service run within the Borough from Keighley Institute, in the centre of the town, to the termini at Ingrow, Stockbridge, and Otley. In the original installation the vehicles used were single-deck vehicles constructed to seat twenty-eight passengers. The wheels were fitted with solid rubber tyres, and 20-h p hub motors were built into the rear wheels.

CHAPTER VII

FROM ROMAN ROADS TO BRITISH TURNPIKES

To wheeled traffic roads are, of course, of the greatest importance The development of transport is therefore largely dependent on the state of the roads, their improvement, and maintenance. The roads of a country may be compared with the veins and arteries of a living organism, and the stream of traffic with the blood-stream of the human body, for it brings life to the villages and towns exactly as the blood in our bodies renews worn tissues and gives life and strength. Until the time when regular coach services were run people did not know what was happening outside their own district for many months in the year. Even during the summer, when the roads were open, they depended on the packman or some chance traveller for news of the outside world. We are told by Macaulay that news of the death of Queen Elizabeth did not reach Devon until the Court had ceased to wear mourning for her! When Cromwell was made Protector the news did not reach Bridgwater until nearly three weeks later, when the church bells were set ringing for joy!

No one recognized more clearly than the Romans that without good roads a country is paralysed. Their first care on conquering a new country was to introduce an efficient system of roads. These roads were made as straight as possible without regard to gradient, and were probably the first to be constructed with a substantial foundation. They were essentially military, however, and were primarily designed to afford quick access to distant parts of the country. Probably their use by wheeled traffic was a secondary consideration

The Romans had two main types of roads: (1) the prætorian

roads, used exclusively for military purposes and under the immediate government of the prætors, or military superiors, and (2) the consular roads, which were the high roads for public use. The distinction between these two classes of road was so marked that where roads for both purposes were required between the same places separate roads were constructed, even although this might result in their running practically parallel for their entire length.

The prætorian roads were naturally regarded as of the greater importance, for on their construction and maintenance depended not only security at home, but also the security of conquered countries abroad. These roads were generally at least 50 feet in width, with an elevated middle portion some 20 feet in width. When the roads crossed marshy ground they were raised 5, 10, or sometimes even 20 feet by embankments. The consular roads were made and maintained by the consuls, and were generally named after the particular consul who was responsible for their construction—thus the Via Aurelia was made by the Consul Aurelius, the Via Appia by the Consul Appius, and so on. As in the case of the prætorian roads, the consular roads were often remarkable for their breadth. They also were raised at the middle, had channels to carry off the water, and were paved with stones or covered with some other hard material Many were constructed for two-way traffic, the double carriage-ways being separated by a raised footwalk paved with brick.

In addition to the two main classes of roads already mentioned there were by-roads, leading to small places away from the great lines. These roads were called *viæ vicinalæ*, or vicinal roads, and sometimes *viæ patriæ*, or country roads Square gatehouses, with arched openings on each side, were erected at points where these roads crossed

It may perhaps be of interest to mention that milestones were introduced by Caius Gracchus about 130 B.C. They denoted the distance from Rome, a military column—*milli-*

aurum aureum, or golden standard—in the Forum at Rome serving as the centre from which all roads radiated.

In the time of the early Britons Britain was almost covered with forests, which largely determined the site of the earliest settlements Twelve hundred years ago Bede described one of these early forests as being "thick and inaccessible, the abode of deer, swine, and wolves" It was natural, therefore, that the Britons should make their homes in districts that were comparatively open, such as the downs of Wiltshire, the moors of Devonshire, and the wolds of Yorkshire. Even in prehistoric times the importance of communication was recognized, however, and between the villages of the different tribes rough tracks were made by the constant passage of the feet of men and animals over the same path One particular example of these ancient trackways runs through Cock Mill Wood, near Whitby, in Yorkshire, and another ran from the North Downs, in Kent, probably on a line subsequently followed by the great Roman road named Watling Street. Others are to be met with elsewhere, especially in the South of England, and in many parts of the country traces of these ancient trackways of the early Britons are still to be seen. They followed the nearest and most convenient path between two points, and in some cases they were adopted as the routes of later days

The course of these early trackways was determined by the physical features of the country through which they passed, and they played an important part in the early history of England and, later, in civil and religious troubles. Many of the trackways were in regular use as trade-routes, as, for instance, the one to which the name Pilgrims' Way was given in medieval times, because of the numbers of pilgrims who journeyed along it, from Winchester to Canterbury, to the shrine of Thomas à Becket The Pilgrims' Way connected the south and south-east, and it was along this ancient trackway that tin was transported from Cornwall to the coast for export to the Continent in the earliest times. Hundreds of years before Cæsar's in-

vasion (55 B.C.)—probably about 1000 B.C.—trading was established by the Britons, first with the Phœnicians, then with the Greeks, and later with Roman Gaul. A Greek historian tells us that tin was transported into Gaul from Cornwall by traders and then carried overland on pack-horses. It is suggested that tin from Britain may have been used in the armour of the warriors who fought in the siege of Troy.

The discovery of tin was of the greatest importance to civilization in general and to roads in particular, upon the development of which it had a marked influence.[1] There were no tin-mines in Europe except in remote Cornwall, and as news of the discovery of bronze spread there must have been an increasing demand for tin. The metal was transported from Cornwall over the ancient trackway to Sandwich, or the Isle of Thanet, and from there it was exported to the Continent. It was Cornish tin that first tempted the Phœnicians out of their inland sea, past the Pillars of Hercules, to brave the terrors of the Atlantic.

Although it is generally supposed that except for trackways there were no roads in Britain before the Romans came, this is not altogether correct. Certainly roads such as those subsequently made by the Romans did not exist, but there were roads of a kind affording a means of communication throughout the land. There seems good reason to suppose that the earliest roads in Britain were made by those pre-Celtic ancestors of the British who—although consisting of many different races—are grouped together and called Iberians. There were probably at least five main roads following the ranges of the Downs and converging on Avebury and Stonehenge. One of the best known to-day is the Pilgrims' Way, already mentioned, which may still be traced for a great part of its length.

Of the other ancient British roads—subsequently improved,

[1] By adding copper, a soft and almost unusable metal, to tin the hard and serviceable metal bronze was produced, opening up entirely new possibilities to those in possession of the secret.

straightened, and developed by the Romans—were the following

Icknield Street, a road that left London in an easterly direction, penetrated into the country of the Iceni about the Wash and Yorkshire. It passed by Newmarket and Dunstable to Streatley, where it branched to the right by the Berkshire Ridgeway to Avebury; and to the left to Newbury and Tangley, to Dorchester, Honiton, Exeter, Totnes, and Land's End

Ermyn [1] Street, which joined London with the North and with the south coast, was developed by the Romans, and eventually ran from Pevensey to Eastbourne, Wadhurst, Tonbridge, Bromley, and to London, thence, through what is now Wood Green, Enfield, and Ware Park, to Royston, Chesterton, Stamford, Ancaster, Lincoln, and Catterick Here it branched, one road going by way of Corbridge, Brampton, and Berwick to the east of Scotland, and the other branch—along the Ryknield Way—to Aldborough, Houghton, Doncaster, and Staveley. A western branch of Ermyn Street ran from London by Dorking and Pulborough to Chichester.

Watling Street [2] was the main road from the south-east coast to Ireland It started at Richborough and ran, by way of London and Worcester, to Festiniog in North Wales Here it branched—to the left for Caernarvon and to the right for Chester, Manchester, and Corbridge, and then to Jedburgh, Cramond, and the North.

Akeman Street crossed the country from east to west by way of Bedford, Buckingham, Alcester, Woodstock, Cirencester, Anst (where it crossed the Severn), to Caerleon, Cardiff, Carmarthen, and St David's.

Ryknield Street joined the North with the West, leading

[1] The name is supposed to be derived from Ermin, a Saxon hero or divinity

[2] Watling Street existed before the Romans came to Britain The name may be connected with the 'wattle' used for making fences, and perhaps the road was so called because it led to a fenced and sacred enclosure on the site of St Paul's Churchyard (which stands on the famous road), where there was possibly a Druidical temple

from the Tyne by way of Bruchester, Boroughbridge, Aldborough, Ribston, Bolton, Chesterfield, Birmingham, Tewkesbury, Gloucester, Chepstow, Abergavenny, and Carmarthen, to St David's.

The Fosse Way ran from Exeter by way of Seaton, Ilchester, Bath, Cirencester, Northleach, and Claychester to Lincoln It was a wonderful example of road-construction, never deviating six miles from a straight line at any point of the 182 miles between South Petherton and Lincoln In later times the Fosse Way was evidently regarded as an important landmark, for we find it often marking the boundary of a parish or county, in which it has a parallel in the Peddar's Road, which served a similar purpose in Suffolk Much of the old Fosse Way can be traced even to-day, although, strangely enough, the road is practically omitted from an early road-map constructed in A D 1300 and now in the Bodleian Library Neither is it shown in later old road-maps and books, with the exception of a small section that is shown in the old itineraries of Bowles, Paterson, and Mogg as a coaching road between Stow-on-the Wold and Cirencester. The road to-day runs through about 200 miles of England that is remarkably thinly populated, and for miles one may walk along it without passing a house or an inn or without meeting a traveller. Yet in Roman times it was an important road through England, and perhaps the most important place on it was Cirencester, now an agricultural and hunting centre, but once a great junction of main roads that radiated from it as spokes radiate from the hub of a wheel

In some parts of Britain the earliest roads were known as 'drifts' or 'droveways,' being so called because of the passage of 'drifts' of cattle that were driven to enclosed places for annual inspection. Drifts were followed by pack-roads, or 'prime-ways,' then by horseways and footways, and finally by the king's highway.

Although—as we have seen—there was no extensive system of roads in Britain until the Romans came, the early British

roads were planned systematically to meet As far as possible they avoided physical obstacles, adapting themselves to the lie of the country In this they differed materially from the roads of the Romans, which ignored natural obstacles and ran across the country up hill and down dale with an imperial disregard of difficulties. As far as possible the Roman roads preserved a direct line, the Romans taking the highest points of the land as surveying-posts to maintain the line Exactly how the Roman engineers took the 'sights' for their great military highways is something of a mystery, as, of course, our present-day precision of measurement and our modern scientific instruments—the telescope, the vernier, and the theodolite—were unknown to them

After the Romans left Britain (in A D. 410) the roads fell into disrepair. The Jutes and Saxons established themselves in the south within half a century of the departure of the Romans, and in another century they and the Angles held the whole of the east and south-east coasts At last, the British having been driven westward, the conquest was complete The invaders then commenced fierce wars among themselves, and during this period little is known about either roads or conveyances We do know, however, that King Harold's army marched at the rate of nearly eighteen miles a day from Stamford to Hastings to fight William of Normandy. This was a wonderful feat for infantry, and the roads must have been fairly good to make it possible, for the army would be accompanied by a considerable amount of transport. After the Norman Conquest the country was too disturbed to give attention to roads, which for the most part were allowed to go to ruin. Indeed, we do not hear anything of importance in this connexion until after several reigns subsequent to the Conquest The first improvements to be made were in the roads to the seaports on the south coast, to facilitate the passage of the Normans in their constant travels between the Continent and England. By the time of the Plantagenets the roads from London to the ports

were in fairly good condition, but the roads to the north and west remained in a ruinous state for some centuries, and consequently the transport of the country had to be carried on by pack-horses.

In the reign of Edward I several Acts were passed largely in the hope of suppressing the depredations of desperate characters who haunted the roads outside the towns and preyed on lonely travellers

Books were published about this time exposing the practices and haunts of robbers and detailing the various disguises affected by the thieves.

The difficulty of transport resulted in the import of large quantities of foreign goods, and at this time England was a producer of raw materials—wool, hides, etc.—that were manufactured on the Continent. Manufacture demands transport facilities for both raw materials and manufactured goods, and when Edward III (1327–77) came to the throne a new policy was gradually evolved. Henry II had replaced compulsory personal service by money payments, but Edward found the financial arrangements inadequate and decided to increase the taxes. To do this he determined that the raw materials hitherto exported for Continental manufacture must be manufactured in England, in the hope that he would thereby collect increased taxes from the tradespeople, the sheriffs having discovered that money was more easily extracted from townsmen than from agriculturists Advantages were offered to Continental craftsmen to come to England and set up their manufactories here, and as a result many valuable industries were established in this country. Every new industry made further demands on the means of communication, and it became increasingly necessary as time went on that transport methods should be improved

Naturally the condition of the roads was among the first matters to receive attention, and in the reign of Edward III a system of tolls was devised. The idea was that the toll

collected from the users of the roads would be sufficient not only to keep the roads in repair, but even to extend their length In 1346 the King granted his commission

> to the Master of the Hospital of St Giles-in-the-Fields, without the city of London, and to John of Holborn, to lay a toll on all sorts of carriages, for two years to come, passing through the highway leading from the said hospital to the Bar of the Old Temple of London. Also through another certain highway called Perpoole,[1] joining to the beforenamed highway.

According to the Act of Parliament, the footpath at Temple Bar was overgrown, and the road had "by the frequent passage of carts, wagons and horses, to and from London, become so miry and deep as to be almost impassable." When Edward rode to Parliament the roads in Westminster were in such a bad state that the ruts and holes had to be filled with faggots to make a suitable passage for the royal procession About this time Knightsbridge, which is to-day a wide, beautifully paved road, was a narrow lane, where travellers had to wade through deep mud! Another main road not far away was described as being "an impassable gulf of mud."

If this was the state of things in and near London we can well understand that the roads elsewhere were in an even worse condition. The trading routes had become more and more deeply worn, so that they were named 'hollow-ways.' Some were worn to such an extent that the pack-animals using them were barely visible to people on the level. Some were crossed here and there by rivulets and streams, and all were full of holes The surface of the roads was not improved by the fact that the wheels of many of the cumbersome carts of the period were studded with heavy nails, in order that they might obtain a better grip.

Little was done, however, until the reign of Henry VIII (1509–47), when laws were passed for the improvement of old

[1] Later Gray's Inn Lane.

roads and the making of new roads. Special mention was made of the roads between St Clement Danes, in the Strand, and Charing Cross, and between Holborn and Southwark—these roads being then both "noxious and very jeopardous." At the same time it was proposed to alter or remove certain roads in the Weald of Kent and in "the deep ways of Sussex," where the old roads are described as being "worn out"! They had "become so deep and noyous by wearing and course of water, and other occasions, that people cannot have their passages and carriages by horses upon or by the same way, but to their great pains, perils, and jeopardy." The Act cannot be said to have been encouraging to would-be road-makers, however, for it simply gave permission to any person to "lay out a more commodious way" on his ground, in return for which work he was given the right to add to his lands the soil and ground of the old way!

In 1537, when Henry VIII began to suppress the monasteries, a monastery-wrecker named Richard Bellasis stated that he could not proceed with his work of dismantling Jervaulx Abbey, in Yorkshire, owing to the bad state of the roads He reported that "lead from the roof cannot be conveyed away until next summer, for the ways in that countrie are so foule and deepe that no carriage can pass in winter."

In 1555 it was enacted that as

> the highways were then very noisome and tedious to travel in, and dangerous to all persons and carriages . every parish shall annually elect two surveyors of the highways, to see that the parishioners, according to their lands, abilities, farms, etc , send their carts, horses, men, and tools, four days in every year for mending the roads.

Farmers were slow to respond, however, and invariably sent their worst horses and carts and their laziest men, who passed the compulsory four days in lolling about the roadside. Others used their men for the compulsory four days in repair-

ing those parts of the road that led to their own farms. Thus the public did not get much benefit from that Act.

Nineteen Acts relating to the roads were passed in Elizabeth's reign (1558–1603) and one in James I's (1603–25), after which there was none until the Restoration

In the meantime traffic increased, and the roads suffered so severely that in 1629 Charles I issued a proclamation that "no common carrier, or other person whatsoever, shall travel with any waine, cart, or carriage with more than two wheels, not with above the weight of twenty hundred, nor shall draw any waine, cart, or other carriage with above five horses at once"

It is recorded that, on one occasion, eight hundred horses were captured by Cromwell's forces while sticking in the mud. When a long journey was contemplated during the seventeenth century servants were often sent beforehand to survey the country and to discover the most promising track In 1640 the road from London to Dover was the best in England, and yet for even that short distance the journey of Queen Henrietta and her household required four weary days.

In 1663, in the reign of Charles II, the first Turnpike Act was passed. It stated that

> the ancient highway and post-road leading from London to York, and so into Scotland, and likewise from London into Lincolnshire . is very ruinous, and become almost impassable, insomuch that it is very dangerous to all his Majesty's liege people that pass that way

Justices of the Peace were to appoint persons to take

> sumes of money in the name of Toll or Customs, to bee paid for all such horses, carts, coaches, waggons, droves, and gangs of cattell as shall passe that waye

The toll for a horse was one penny, for a coach sixpence, for a wagon one shilling, for a cart eightpence, for a score of sheep or lambs a halfpenny, for a score of oxen fivepence, for a

-e of hogs twopence. If any person refused to pay th horse or coach was to be detained and held until th paid. Seven years later another Act imposed pen persons forcibly opposing the detention of cattle, etc -payment of tolls

rom many sources we gain an idea of the general sta

FIG 24 A TOLL-GATE

roads throughout the country at this time In Derby ellers were in constant fear of their necks, and were ntly compelled to alight and lead their beasts [1] The 1 through Wales to Holyhead was in such a state th the Viceroy, going to Ireland, was five hours in trave fourteen miles from St Asaph to Conway. Between and Beaumaris he was forced to walk a great part o , and his lady was carried on a litter His coach was iiderable difficulty, and by the help of many hands, bro

[1] *Tour in Derbyshire* (1662).

after him in time. In general, carriages were taken to pieces at Conway and borne on the shoulders of sturdy Welsh peasants to the Menai Strait.[1]

When Prince George of Denmark visited the stately mansion of Petworth in wet weather he was six hours in going nine miles, and it was necessary that a body of sturdy hinds should be on each side of his coach in order to support it. Several of the carriages that conveyed his retinue were upset and injured. A letter from one of his gentlemen-in-waiting has been preserved, in which the unfortunate courtier complained that during fourteen hours he never once alighted except when his coach was overturned or stuck fast in the mud.[2]

Daniel Defoe wrote just before 1700:

> Supposing one takes the North Road by St Albans; after Dunstable the road disappears into deep clay, surprisingly soft, perfectly frightful. The great number of horses killed there by excess of labour in the clay is such an expense to the country

that he wonders if the building of new causeways such as the Romans built would not be less expensive. About the same time Pickfords, the carriers, lost a wagon and six horses, which were engulfed in the mud at Fenny Stratford.

The preamble to an Act in the time of William and Mary (1689–94) set forth the fact that the highways were not "in many parts sufficiently amended and repaired, but remain almost impassable, all which is occasioned, not only by reason of some ambiguities in the said laws, but by want of a sufficient provision to compel execution of the same." The Act directed that previous laws were to be enforced, with penalties if the responsible persons did not carry them out Roadways to market-towns were to be made at least 8 feet in width and "as near even and level as may be." The Act also set forth

[1] *Correspondence of Henry, Earl of Clarendon*, December 30, 1685, to January 1, 1686

[2] *Annals of Queen Anne*, 1703

that as "divers waggoners and other carriers, by combination among themselves, have raised the prices of the carriage of goods in many places to excessive rates, to the great injury of trade," the Justices of the Peace were to have the power of settling the rates to be charged for land carriage.

Another Act of the same reign directed that when two or more crossways met posts should be erected with inscriptions in large letters showing the name of the next market-town to which each of the highways led

In Queen Anne's reign (1702–14) it became the practice to load wagons so heavily that the roads were cut into deep ruts An Act was therefore passed compelling the use of a pole or shafts for wheel-horses, and prohibiting the use of more than six horses or oxen to one wagon, except on hills

In George I's reign (1714–27) the use of five horses only was permitted to one wagon—except for purposes of husbandry or for his Majesty's service—because excessive loads were still being carried, damaging the roads so that they became almost impassable By this Act the weights to be carried by wagons and carts were also limited—no more than twelve sacks of meal, each of no more than five bushels; twelve quarters of malt; seven hundred and a half of bricks; and one chalder of coals Any person offending was to forfeit one of the horses drawing the load. Such laws as these, however, laid the carrier open to a form of robbery from men who wandered over the country and made a trade in laying informations The informer took care to post himself on a turnpike road, near a place where some narrow lane opened into it In these carriages with broad wheels could scarcely move at all. To overcome the difficulty carriers were frequently tempted to yoke more beasts than the existing Acts allowed. When the informer observed a wagon drawn by additional beasts coming out of one of these ravines he seldom allowed the driver time to take off his supernumerary animals, but, jumping from the hedge, gave notice of his intention to inform. In this way he

xtorted money—a system of robbery on the highways "as ffectual as, and scarcely more innocent than, if extorted under error of the pistol"

In the days of the stage-coach highwaymen infested the oads, and many are the stories told of the Dick Turpins, laude Duvals, and Jack Sheppards of the time. According o Macaulay,

> The public authorities seem to have been often at a loss how to deal with the plunderers. At one time it was announced in *The Gazette* that several persons, who were strongly suspected of being highwaymen, but against whom there was not sufficient evidence, would be paraded at Newgate in riding-dresses; their horses would also be shown; and all gentlemen who had been robbed were invited to inspect this singular exhibition . . .
>
> It was related how Claude Duval, the French page of the Duke of Richmond, took to the road, became captain of a formidable gang, and had the honour to be named first in a royal proclamation against notorious offenders; how at the head of his troop he stopped a lady's coach, in which there was a booty of £400, how he took only £100, and suffered the fair owner to ransom the rest by dancing a coranto with him on the heath, how his vivacious gallantry stole away the hearts of all women; how his dexterity at sword and pistol made him a terror to all men, how, at length, in the year 1670, he was seized when overcome by wine; how dames of high rank visited him in prison, and with tears interceded for his life; how the King would have granted a pardon, but for the interference of Judge Morton, the terror of highwaymen, who threatened to resign his office unless the law were carried into full effect; and how, after the execution, the corpse lay in state with all the pomp of scutcheons, wax lights, black hangings, and mutes, till the same cruel Judge, who had intercepted the mercy of the Crown, sent officers to disturb the obsequies. . .
>
> All the various dangers by which the traveller was beset were greatly increased by darkness. He was therefore commonly desirous of having the shelter of a roof during the night, and such shelter it was not difficult to obtain

THE TURNPIKE RIOTS

Many Acts for the improvement of the roads were passed in the subsequent reigns of the Georges. Between 1760 and 1780 no less than six hundred Turnpike Acts were passed, authorizing the construction of new roads. During the eight years following the running of the first mail-coach (1784) over three hundred Acts were passed for the same purpose. There was so much to be done throughout the country, however, that, despite every effort, the highways remained in a very bad state. Traffic had increased, too, imposing greater wear than ever on the roads, and especially was this the case on the roads near London

Despite the bad state of the roads and the discomfort and delay occasioned thereby, much hostility was shown to plans for improvements Turnpike [1] tolls were installed, money for the construction and maintenance of the roads being borrowed on their security by the local parishes In England this seemed to be the only way by which better roads could be obtained, but the imposition of the tolls was the cause of grave disorders.[2] The Turnpike Riots broke out in various parts of the country in 1728, and in 1736 there were more riots Reynolds, a ringleader, was hanged at Tyburn, but the hangman cut him down too soon, and while being placed in a coffin he revived. He was rescued by the mob, only to die later in a house to which he had been taken. In 1749 there were again riots in Gloucestershire and Somerset, and turnpikes near Bristol and Bedminster were destroyed. The latter gate had to be guarded by armed sailors, but even then the mob succeeded in destroying the gate for a third time.

In 1753 a general attack was made on all the toll-gates in Yorkshire, the resistance to the tax having been greatest along

[1] The barrier to stop the traffic while the toll was paid was originally a frame consisting of two cross-bars, armed with 'pikes,' or pointed bars, that turned on a pivot, hence the name 'turnpike' The toll-gatherer, who lived in the toll-house, was known as the 'pikeman'

[2] In France the nobility made their roads by the forced labour of the peasants This was one of the oppressions that ultimately led to the Revolution.

the line of the Great North Road At Selby the public bellman summoned the inhabitants to assemble with their hatchets and axes at midnight to cut down the turnpikes, and they were not slow in obeying the summons! Military assistance was sent to protect the toll-bars, but this was a difficult matter, for the toll-bars were numerous. Wherever one was left unprotected, even for a night, it was found destroyed next morning. The Yeadon and Otley mobs were especially violent, and in June 1753 made raids in which they destroyed a dozen turnpikes in a week. A score of the rioters were apprehended and taken to York Castle On their way there a rescue was attempted, and many persons were killed and injured. This opposition did not prevent progress being made, however, and between 1760 and 1774 no fewer than 452 Acts were passed for making and repairing highways Road-making as a profession was unknown at this time, for it was not considered that any great skill was necessary. Thus it came about that the first professional road-maker was a blind man, with no engineering experience and, indeed, with no particular trade. To this man, Metcalf, we shall refer at greater length in our next chapter

The turnpikes were adversely affected by the coming of the railways, soon after the introduction of which turnpike bonds, which were formerly regarded as being among the safest and most profitable investments, became valueless In 1838 (the period when railways began to supersede roads) the total number of turnpike trusts in England and Wales exceeded eleven hundred The debts of the trusts at that time amounted to £8,500,000, of which £1,000,000 was unpaid interest They paid £300,000 interest annually upon bond debts amounting to £7,100,000. The annual income from tolls was £1,800,000, and the expenditure in making, maintenance, and improvements £1,064,000; in management £135,000.

The last of the turnpikes (that of the Holyhead road in Anglesey) regulated by the General Turnpike Acts was

abolished on November 1, 1895, although there remained in several parts of the country 'private toll-bars.'[1] To-day, as we travel about, we may sometimes see relics of the past in the form of quaint, disused toll-bars These little buildings, which survive generally in the form of cottage-dwellings, stand by the roadside, or at junctions of cross-roads. There are several in North Wales between Llangollen and Holyhead. The abolition of turnpikes had the effect of reverting to the old principle of local liability for road maintenance, with this difference, however, that the charges were borne by the ratepayers as a body, and not by landowners only To a certain extent, the unfairness of this system is now modified by grants from the Exchequer in aid of expenditure on main roads

[1] Bridge-tolls are of much older origin, and have not yet entirely disappeared

CHAPTER VIII

THE DEVELOPMENT OF MODERN ROADS

A GREAT change in the condition of roads came about as a result of the mechanical inventions that speeded up the textile industries. Trade increased to such an extent, with a consequent increase on the requirements for greater transport facilities, that the Government was compelled to develop better means of communication. Up to this time there had been few engineers of eminence, and none who had paid any attention to road-making, which was regarded as a task beneath the dignity of an engineer As late as 1768 it was considered remarkable that the engineer Smeaton should condescend to make a road across the valley of the Trent between Markham and Newark. The usual method of repairing the roads was roughly to spread stones from the nearest quarry, instead of breaking them up to a uniform size and laying them carefully on the road The stones were not formed into a surface, but were left to be crushed into position by the wheels of passing carts and wagons

It is thus not so extraordinary as might otherwise appear that the first maker of really satisfactory roads was a blind man This man stands out, however, as a great figure, who contributed very materially to the establishment of the system of transport that was to be the basis of England's industrial greatness.

John Metcalf, born in 1717 at Knaresborough in Yorkshire, was the son of poor working people. He was not born blind, but a severe attack of smallpox when he was six years old resulted in the loss of his sight. When he was sufficiently recovered to be able to go out again he began to find his

way about by groping from door to door along the walls on either side of his home. In about six months he could find his way to the end of the street without a guide, and three years later he was able to go on errands to any part of the town

Metcalf was an exceptionally strong and healthy boy, and, as his confidence in finding his way about increased, he naturally became eager to associate in the games and sports of boys of his own age He joined his companions in bird-nesting expeditions and soon became an expert climber. In addition he spent many happy hours in roaming about the fields and lanes until he came to know every foot of the ground for miles around Knaresborough. In the evenings he learned to play the violin, becoming so proficient that he was offered engagements to play at country dances; and subsequently he secured regular engagements at Harrogate and Ripon.

Metcalf grew to be 6 feet 2 inches in height, and he was a man of fine physique. He saved sufficient money to buy a horse and became an expert rider A great affection grew between horse and man, and riding became one of his greatest pleasures. He travelled about alone in a remarkable fashion, and many stories are told of the extraordinary manner in which he overcame the handicap of blindness. He visited London twice, and on the second occasion he was entertained by Colonel Liddell, of Ravensworth Castle. When the time came for Metcalf to return the Colonel offered him a seat on his coach, but the offer was declined, Metcalf calmly saying that he could walk as far in a day as the Colonel was likely to travel in his coach. It seems almost incredible that a blind man should suppose he could walk 200 miles over a strange road in the same time that a coach could perform the journey, yet Metcalf actually arrived at Harrogate before the Colonel. The explanation of the slowness of the coach lies in the really terrible state of the roads, which made travelling on foot the fastest mode of progression. (There is a story of a man with

a wooden leg who was offered a lift on a stage-coach, an offer that he declined on the ground that he was in a hurry!)

During the rebellion that broke out in 1745 Metcalf did a considerable amount of fighting, and became well known as "Blind Jack" After the battle of Culloden he returned home to take up the more peaceful pursuit of a general carrier between York and Knaresborough. It was about the year 1765, while engaged in this occupation, that he became interested in a scheme to construct a turnpike road between Harrogate and Boroughbridge. The necessary Act of Parliament authorizing the making of this road had been passed, but in such a remote country district the surveyor found it difficult to discover a man who was capable of carrying out the work During his wanderings about the country Metcalf had thought a good deal about the universally bad state of the roads. He was shrewd enough to foresee that a new and promising line of business would be opened up if the Harrogate and Boroughbridge road could be constructed successfully, for probably it would be the first of many similar highways He therefore approached the surveyor with an offer to construct three miles of the proposed road, between Minskip and Fearnsby. Such was the surveyor's confidence in the blind man's ability that he gave him the contract immediately

Having sold his stage-wagons and his interest in the carrying business, Metcalf tackled his new undertaking with the greatest vigour. The material for constructing the whole length of the road was to be procured from one gravel-pit, and Metcalf made elaborate arrangements for hauling out the ballast and distributing it to the road gangs with speed and economy. The work proceeded rapidly and without a hitch, the contract was completed to the entire satisfaction of the surveyor, and Metcalf's reputation became enhanced.

Shortly afterwards tenders were invited for the building of a bridge at Boroughbridge, and Metcalf sent in a tender that was accepted. This task was entirely new to him, but he com-

pleted it satisfactorily within the contract time. Subsequently he constructed numerous roads and bridges with great success. His roads lasted well, and after times of heavy flood he was able to point with pride to his bridges, all of which were standing, while many constructed by other builders had collapsed

When a road from Huddersfield to Manchester was decided upon, Metcalf contracted to make it at so much a rood, before the line of the road had been marked out Subsequently, to his dismay, he found that the surveyor's route involved crossing some deep marshy ground on Pule and Standish Commons He pointed out to the trustees that he would be involved in much greater expense by following the surveyor's line, but the trustees assured him that, if he succeeded in completing the road to their satisfaction, he would not be a loser. In the opinion of the surveyor it was necessary to dig out the bog until a solid foundation was reached, but Metcalf realized that not only would this be a slow and costly proceeding, but in the end the road would be unsatisfactory. He pointed this out to the trustees, but they refused to allow the road to pass round the marshy land Metcalf was thus placed in a difficult position Finally, after much thought, he solved the problem by persuading the trustees to allow him to make the road across the marshes in his own manner on condition that, if it proved unsatisfactory, he would reconstruct it at his own expense on the surveyor's plan.

The contract stipulated that nine miles of the road must be completed within ten months, and Metcalf, having gained his point, lost no time in commencing the preliminary operations. Soon he had nearly four hundred men engaged on the work at six different points. The main difficulty lay in rendering the road practicable for heavy vehicles, and in order to make this possible Metcalf ordered great quantities of heather to be pulled and bound up into small bundles of a size that conveniently could be grasped with the hand These bundles were placed close together in rows in the direction of the

line of road, and afterwards similar bundles were laid down transversely upon them, the whole being well pressed down Stones and gravel were then spread over the bundles, and a firm and level road was produced. The work had been watched with keen interest by a crowd of spectators, who had assembled in full expectation of seeing both horses and wagons disappear in the bog. These expectations were not realized, however, and when the first wagon to cross reached firm ground in safety it was greeted with loud cheers. The whole length across the marshes was completed in the same manner, and this section proved one of the best and driest parts of the whole road. Metcalf's method of building this road across the marshes was the same as that subsequently adopted by Stephenson in carrying the Liverpool and Manchester Railway across Chat Moss.

Metcalf continued road-making for over thirty years. His last road was between Haslingden and Accrington, with a branch road to Bury, which proved to be one of the most difficult works he had undertaken He completed this road in 1792 at the age of seventy-five, and afterwards retired to Spofforth, near Wetherby, where he spent his remaining years on a small farm. He died peacefully in 1810 in his ninety-third year, leaving behind him a wonderful record of triumph over one of the most terrible of all physical disabilities

While road-making was thus proceeding in the industrial areas of Lancashire and Yorkshire progress was also being made elsewhere In Scotland means of transport were far more difficult to provide, for the country was rugged and broken. Although England and Scotland had been finally united in 1707, the Jacobites continued to attempt to regain possession. Between 1715 and 1745 some eight hundred miles of military roads had been constructed, however, and later—with the opening of the Scottish iron trade—efforts were made to develop the country further by making more roads Thomas Telford, the engineer who is chiefly re-

membered as the builder of the Menai Strait Suspension Bridge, was commissioned by the Government to draw up a scheme, and in his report to the Lords of the Treasury (made in the autumn of 1802) he pointed out that previous to 1732 the roads in the northern parts of Scotland were mere tracks; that the military roads subsequently made were little adapted to civil purposes; and that, although bridges were then constructed over some of the smaller streams, yet the principal rivers could only be crossed by inconvenient and dangerous ferries Telford's report formed the basis of a great scheme of development, especially in regard to the Highlands, where the absence of roads and bridges was a very serious handicap to progress of any kind; and in 1803 a Parliamentary Commission was appointed and a series of improvements commenced In the course of eighteen years upward of 920 miles of new roads were made in the Highlands under Telford's system, in connexion with which 1117 bridges were built.

One of the most important of the new bridges constructed under Telford's supervision was that over the river Tay at Dunkeld. This occupied three years in the building, and was opened for traffic in 1809. It was a handsome structure with five river- and two land-arches The span of the two centre arches was 90 feet, and that of the two adjoining ones 84 feet Its cost was about £14,000, half of which was defrayed by the Duke of Atholl.

At this period coaches were running between most of the chief towns, but the longer journeys were difficult and slow on account of the extremely bad condition of the roads. This was especially the case with the highways connecting London with the chief towns of Scotland Some idea of the conditions may be gained from the fact that on one occasion a coach and horses actually fell through a certain bridge, this accident resulting in the death of the coachman and one passenger, while several other passengers were seriously injured. In 1814 a Parliamentary committee declared the road between Carlisle

and Glasgow to be in such a bad state as to cause serious delay to the mails and danger to the lives of passengers. Local efforts to put the road in a fit condition having failed, it was decided to undertake its reconstruction as a work of national importance. Telford was placed in charge of the work, and he constructed nearly seventy miles of new road of a quality not previously attained. In this work Telford had two chief objects—to make the road as level as possible and to give it a surface capable of bearing without injury the heaviest weights likely to pass over it. He constructed the metal bed in two layers rising about 4 inches towards the centre of the road. The bottom layer was of stones 7 inches in depth, set by hand with their broadest ends downward, and cross-bonded or jointed, no stone being more than 3 inches wide at the top. The space between these stones was filled with smaller stones packed by hand so as to produce a firm and even surface, with a drain leading to the outside ditch every hundred yards. On this lower layer was laid a second layer, 7 inches in depth, of hard stone broken small, and surmounted by a binding of gravel, to the depth of about an inch. The result of this careful construction was a firm, hard, dry road, needing little in the way of repairs.

The success of this road led to great activity in road repairing in various parts of the country, and Telford's services were in constant demand. His most notable work was the improvement of the roads between London and Holyhead. The journey from London to Dublin by way of Holyhead was a serious undertaking involving considerable danger. On the Irish side there was nothing worthy the name of port, and after crossing the Irish Sea passengers were put ashore at Holyhead on the rough rocks, without any landing convenience! From there the road across Anglesey was merely a rough track.

Communication with Ireland became of considerable importance following the Treaty of Union in 1800, for the roads

were used by the Irish Members in their journeys to and from Westminster. These roads were in a very bad state, and the Irish Members complained loudly of the dangers to which they were exposed

After the legs of three saddle-horses had been broken within a week, a coachman had fractured one of his thighs by being thrown on to the road, and a passenger been shot into a pool, the London coachmen refused to work on so dangerous a road The matter was then considered pressing, and a Parliamentary Commission was appointed. Telford, on being consulted, undertook to superintend the construction of a good coach-road from Shrewsbury to Holyhead. By that time Telford had established his principles of road-making. These depended on the recognition of the importance of straightness and level, of a solid bed formed of hand-laid stones of small size, of efficient drainage, of a convex surface, and of prompt repairs of imperfections.

Telford's work resulted in such a great improvement to the London-Holyhead road that the journey of 260 miles, which had previously taken 41 hours to accomplish, could be regularly performed in 27 hours. Telford had the satisfaction of knowing that the Holyhead mail had become in his lifetime the fastest coach out of London, maintaining what was then considered the extraordinary speed of 10¼ miles an hour, exclusive of stoppages

Another famous road-maker, a contemporary of Telford who also did much to improve the roads, was John Loudon McAdam (1756–1836) His system of road-construction was based on the recognition of the importance of making the surface of the road waterproof. He was of the opinion that in the old-fashioned roads the clay became waterlogged, and thus was unable to sustain the weight of the traffic during the wet winters Previously, when rounded pebbles had been used, they slipped from under the wheels of the traffic, leaving the surface of the road uneven. McAdam's method was to

lay an improved surface of granite and other hard stones and flints. These were broken into small, angular pieces, which became welded together into a compact and stone-like mass by pressure and the use of water and mud. Like Telford, McAdam adopted a uniform cross-section of moderate curvature, with a rise of not more than a fortieth of the width and a ruling gradient of 1 in 30. He considered it of great importance that when roads were made they should not be abandoned to chance and be repaired only when they had become almost impassable. He contended that a newly macadamized road should be watched for some time after its construction, and that every inequality should be filled up at once so as to maintain a hard and level surface. The road would then last for years without further attention, and it would matter little what wheels or weights travelled over it Some of McAdam's views are now held to be erroneous—as, for instance, the small importance he attached to the foundations—but he was very persistent in his endeavours to secure improvement, and for this he deserves much credit. McAdam was rewarded for his work by a grant of £10,000 from the Government, but he declined a proffered knighthood—an honour that subsequently was conferred upon his son.

Modern macadamized roads consist of a lower layer of broken stone, well rolled with a layer of broken granite and consolidated with sand, gravel, and stone chips Sometimes a concrete foundation is used in place of the broken stone The roadway varies from 6 to 12 inches in depth, according to the weight of traffic on the road

The dust that rose from the early macadamized roads has now been eliminated. At first this was done by spraying tar directly on to the roads, and by repeating this operation from time to time the surface was preserved continuously. Later tar macadam was used. This consists of broken stone coated with some bituminous compound rolled and 'top-dressed' with stone chips—generally hard limestone or blast-furnace

slag. The full value of McAdam's ideas was not felt until the introduction of the steam-roller (in 1863) by Messrs Clark and Bath. At first rollers were of the two-wheeled type, but in 1871 the three-wheeled type was introduced by Thomas Aveling. To-day the original two-wheeled type has been revived in the smaller petrol-driven motors now in common use

Road-makers have used various materials for the surfacing of their roads In towns and cities in the early days streets were paved with large pebbles or cobble-stones, bedded on sand or gravel Later Telford suggested using squared blocks laid on a foundation of broken stone. In 1840 stone setts on Blackfriars Bridge were jointed with mortar and laid in a concrete foundation 12 inches thick. At the present time it is usual to employ granite setts of uniform size where there is heavy traffic Wood blocks, laid on concrete foundations, have been used with considerable success in most large towns —they were first used in Manchester in 1839 Creosoted Australian hard woods and American red-gum are those generally used. Trinidad bitumen and asphalt were first used in London in 1836 for pavements. The first stretch of smooth asphalt roadway in London was laid in Threadneedle Street, near Finch Lane.

Experiments extending over many years have been conducted with a view to discovering some new type of surface suitable for both horse and motor traffic Some novel and widely differing materials have been tried out in the endeavour to find an ideal road surface to withstand the heavy shocks and wear and tear of modern traffic. It is claimed that rubber blocks obviate many of these difficulties and that they have a wearing period of about fifteen years—twice that of wood blocks—but they have not yet been adopted. If rubber blocks justify all the claims made for them, they will not only reduce the wear and tear of all forms of road transport vehicles to a minimum, but will also solve the noise problem that has been baffling experts for years. French engineers have produced a

road surfaced with glass that possesses distinct advantages and hard-wearing qualities. It is composed of devitrified waste glass—such as old broken bottles subjected to a heavy pressure in moulds, and so formed into bricks of extreme durability It has been found that the surface is capable of resisting a crushing strain of four tons to the square inch, and curiously enough is not liable to become slippery through wear or in wet weather Continental engineers have also obtained good results with paving 'stones' composed of cork. These possess the advantage of being non-absorbent and noiseless, not liable to expand or contract when laid, and non-slippery when worn.

As a road-making material concrete has many advantages and is being used extensively. One of its chief advantages is its convenience of handling and its adaptability In conjunction with the compressed-air drill (to break up old road-beds) and the use of portable mixers, the quick-setting cements save time both in construction and repair, and speed is always an important consideration, especially in busy streets. A fine example of a concrete road is the one that the Manchester Corporation has made from Moston Lane to Rochdale Road It is one of the widest concrete roads in the country; and has a width of 50 feet from kerb to kerb, the concrete being continued for 2 feet 6 inches under the kerb on each side to provide a bearing for heavy loads resting near the kerb. The concrete is spread to a thickness of 9 inches on a foundation of rolled clinker, below which was peat bog. Although the difficulties of dealing with such a foundation are great, it is claimed that the concrete surface overcomes them It makes a solid roadway that does not give to the yielding of the peat bog, because the weight it is carrying is so widely distributed. In the case of the Manchester road, the concrete was laid across the roadway in one operation, in bays 13 feet 6 inches in length. These bays were laid alternately with gaps —first a bay and then a gap of equal dimensions (the gaps, of

course, being filled in later), so that the inevitable contraction of the concrete was provided for.

Each part of the country presents different problems in road-making. For example, the construction of roads in agricultural districts is accompanied by difficulties that are quite different from those encountered in manufacturing districts, where the traffic is much heavier. Then, again, in London the problem of a constant stream of traffic of all kinds calls for special consideration. During the busiest hours omnibuses pass Charing Cross at the rate of nearly six hundred an hour, or approximately one every six seconds. The stopping and starting of so great a number of heavy vehicles, and the constant strain caused by changing gear at the head and foot of inclines, wear away even the hardest road surface in a comparatively short time.

Because badly made roads may be sources of ill-health or disease to those who live near them, they were dealt with in the Public Health Act of 1875, which increased the responsibilities of boroughs in this connexion. In 1888 the Local Government Act dealt with the maintenance of roads in rural districts With the twentieth-century development of motor transport, however, the question of road maintenance became a national matter, and in 1910 the Road Board was established. Under the Local Government Act of 1929 all main roads, all roads in rural districts, and all classified roads in urban districts and boroughs other than county boroughs, became 'county' roads, and rural district councils ceased to be Highway Authorities. The Act gave power to district councils to apply to the County Council in whose area they are situated for the delegation to them of the functions of the County Council in respect to the maintenance, repair, and improvement of the county roads in the district

There are 179,286 miles of roads in Great Britain, of which 25,996 miles are Class I roads; 15,805 miles Class II roads; and 137,485 unclassified. These roads are maintained by

public funds—by the ratepayer through the local authorities and by the motorist through the Road Fund and the Ministry of Transport. In 1921 the number of motor vehicles on the roads was 873,700, by 1926 the number had doubled, and is now (1931) 2,287,326 of which 1,056,214 are private cars, 724,319 motor-cycles, and 506,793 commercial and other vehicles. Each vehicle pays a tax, graded according to the character of the vehicle and irrespective of its mileage. Some people think that this is a very unfair method of imposing a tax.

CHAPTER IX

HOW RAILWAYS BEGAN

It is rather strange to find that, despite the difficulties and discomforts of travel up to the end of the eighteenth century, the railway was not introduced primarily with a view to facilitating travel from one part of the country to another. Its original function was to meet the requirements of the English coal industry In the early days the coal was taken from the pits to the wharfs for shipment in sacks or panniers on pack-horses, mules, or asses. These were succeeded by two-wheeled carts, which were capable of transporting a larger quantity of coal. The usual load for a horse and cart was a ton, over ten miles in a day, and the cost was about half a crown a ton per mile. After a time the carts were enlarged and mounted on four wheels, thus being converted into wagons. About 1632 the loads per horse were increased to 2 tons, or on a favourable gradient to 4 tons in two wagons.

Attention was next given to making easier the haulage of the wagons, and a form of wooden rail was introduced. These rails were laid parallel on timber sleepers or embedded in the ordinary track, so reducing the amount of friction The introduction of these wooden tram-roads reduced the cost of transport to $3\frac{3}{4}d$ a ton per mile, but the cost was still very heavy. It was found that the wooden rails quickly wore away, however, and so iron plates were nailed to them to protect them from the constant passage of the wagons. The iron plates were not altogether satisfactory, however, and efforts constantly were being made to improve matters.

Cast-iron rails in 3-feet lengths were first used at the Durham

collieries about 1794 They made it possible for a horse to draw from 10 to 12 tons on a level road, over a distance of about twenty-four miles a day The cast-iron railway was called a 'plateway,' on account of the plate-like form of the rails The men who laid the track and kept it in repair were known as 'platelayers,' a name that continues to be used to-day. Both the early wooden and the later cast-iron railways were fitted with a ledge, or flange, on the outer edge of the rail, to prevent the wheels of the wagons from slipping off the rails, but it was not long before this flange was transferred from the rail to the inner side of the wheels. As early as 1789 William Jessop built a railway at Loughborough with cast-iron rails without a flange. Jessop's rails were cast with a kind of foot, through which they were spiked to timber sleepers Later this foot was abandoned, and the rails were placed on 'chairs,' a practice found to be so satisfactory that it has been in use in England ever since.

The earliest steam-propelled vehicles were the road carriages of Watt, Murdock, and Trevithick, and it was from these crude vehicles that the locomotive originated.[1] Richard Trevithick, a Cornishman, has the honour of being the first to run an engine hauling wagons on a railway. In 1804 he completed a locomotive at Pen-y-darren, near Merthyr Tydvil, and on February 13 this engine was successfully tried out on the existing colliery railway. "We put it on the tram-road," wrote Trevithick. "It worked very well, and ran up hill and down with great ease and was very manageable. We had plenty of steam and power" The engine made several trips, on one of which it hauled five wagons, loaded with 10 tons of iron and seventy passengers, for a distance of nine miles at a speed of nearly five miles an hour This historic experiment was made at Trevithick's own expense, for he was convinced that his engine would work with sufficient success to recommend

[1] The development of the steam-engine and Watt's pioneer work in this connexion are described in the author's *Book of Remarkable Machinery* (Harrap, 7*s* 6*d*)

it for general use. The extra strain imposed by the locomotive on the tram-road was such that it could not stand it, however, and since the owners would not incur the necessary expense to keep the track in good condition, Trevithick could not develop his invention further. He designed a locomotive for Christopher Blackett, the owner of Wylam Colliery, in Northumberland, and this was tried out on the Wylam railway, but for some reason or other this engine never went into regular service It was taken to Newcastle, and was used as a fixed engine in an iron foundry there In 1808 Trevithick exhibited a locomotive, nicknamed "Catch-me-who-can," on a circular railway laid down where Euston Square now stands Although this engine aroused considerable attention, it did not lead to anything. Trevithick thereupon gave up locomotive work and turned his attention to other branches of engineering We find him endeavouring to tunnel beneath the Thames, working on the idea of the double expansion and triple expansion engine, making the first steam threshing-machine, and designing the first propeller for steamships. A window in Westminster Abbey commemorates this remarkable man, who has been described as one of the greatest geniuses who ever lived

In 1811 Matthew Murray designed an engine to the order of John Blenkinsop, the 'viewer' (overseer) of Middleton Colliery, near Leeds. The colliery belonged to Charles Brandling, who obtained (in 1758) the first Railway Act ever passed by Parliament The engine—the first public trial of which took place in June 1812—was of original design, and was the prototype of many successful engines designed during the following sixteen years. It had two cylinders, and the pistons drove a pair of cranks at right angles to each other, an arrangement that Murray had patented in 1802. The engine exerted a tractive effort five times as great as Trevithick's, although it was itself no heavier. An original feature was a toothed driving-wheel that engaged in projecting lugs fixed at the

side of the rail to eliminate any possible wheel-slip—a device contributed and patented by Blenkinsop

We have already mentioned that Trevithick designed a locomotive for Blackett, of Wylam Colliery, and that this was apparently unsatisfactory. The success of the Blenkinsop-Murray engines seems to have encouraged Blackett to make further experiments. In 1812 his 'viewer' Hedley, a man of considerable ingenuity, supervised the construction of an engine that was ready for work early in 1813 Although results were disappointing, Hedley was undeterred and produced another design, which resulted in the best engines built up to that time. There seem to have been three of these engines built in 1813—*Puffing Billy*, now in the South Kensington Museum (Plate XVI, *A*), *Wylam Dilly*, in the Edinburgh Museum, and *Lady Mary*. In Hedley's engines the drive from the cylinders was distributed over four pairs of wheels connected by spur-gears, which gave them a greater grip on the rails and made Blenkinsop's rack-and-pinion arrangement unnecessary.

All these locomotives were built and actually running before George Stephenson came on the scene, to improve so considerably the locomotive and lay what was the foundation of the railway system as we know it to-day. Stephenson, born at Wylam on June 9, 1781, was the son of the fireman of the old pumping-engine at the colliery there. When fourteen years of age he was appointed to assist his father, and three years later he became engineman at a new pit at Killingworth. His hobby was his engine, which he often dismantled in his spare time. Realizing the need for a locomotive engine, owing to the cost of transporting the coals by horses from Killingworth, Stephenson determined to study the question. With this end in view, he inspected Hedley's locomotives, and also made a journey to Leeds, where he saw one of Blenkinsop's engines at work drawing sixteen loaded wagons at a speed of three miles an hour Returning to Killingworth, he

o attempt the construction of an engine, and ten ıter he had built the *Blucher*. The engine had a ron boiler and two vertical cylinders, the motion of ıs being transferred to the wheels by spur-gearing. ed out on July 27, 1814, on the railway connected Killingworth colliery, and, although very heavy and

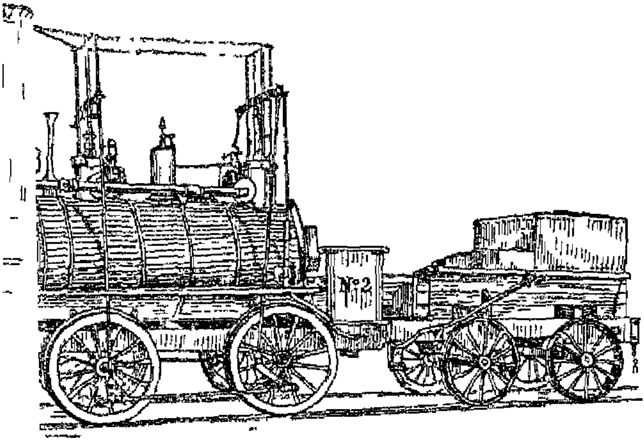


FIG 25 STEPHENSON'S SECOND LOCOMOTIVE

ne, it was found to be a decided advance on previous es. It hauled eight loaded wagons—weighing in 30 tons—at a speed of four miles an hour, up a he steepest part of which was 1 in 330. A second oved engine (Fig. 25) was constructed in March of ing year In this case the piston was connected the engine wheels by cross-bars and connecting-rods. son was now on the threshold of his career as a ıgineer, which commenced with the construction of on and Darlington Railway. In order to under- this—the first passenger-carrying railway in the me into being, we must digress for a moment, in iew the matter in its true perspective

As we have already seen, the only means of land transport up to the beginning of the nineteenth century were pack-horses and, later, carts and wagons Both these methods were slow and expensive—the charge was sometimes as much as £1 sterling per ton for twenty miles It seems to have been generally accepted that the only relief was to be found in the use of rivers and canals, and many Acts were passed before 1800 for the construction of canals in those parts of England where the rivers were not navigable. In a sense, the coal-fields of Northumberland and Durham were well placed for long-distance transport facilities, for the rivers Tyne, Tees, and Wear enabled the coal to be taken by sea to London and elsewhere Because of the natural facilities afforded by the rivers mentioned, and because many of the collieries in Northumberland and some in Durham were within easy reach of shipping facilities, canals had not been found necessary in the north There were rich seams of coal round Bishop Auckland, however, that were situated at some distance from the Tees, whose chief port was Stockton.

In Stockton there were men who were keenly alive to the importance of improving the transport facilities so that the port might benefit from the increased trade. Exactly what form these new means of transport should take was the subject of a long and heated controversy. As early as 1769 Edward Harvey had suggested that a cut should be made in the river Tees at Blue House Point, thereby straightening the course of the river, deepening it, and shortening the distance between Stockton and the sea by two miles. In 1805 a committee was formed to carry out this suggestion, and Edward and Joseph Pease were elected members of this committee. The work was completed, and the opening of the cut was celebrated on September 18, 1810, amid great rejoicing and ringing of bells, followed by a dinner in the Town Hall of Stockton. The success of the new cut seemed to awaken the idea that there were even greater possibilities ahead—even

perhaps the cutting of a canal from Stockton to the South Durham coal-field Rennie, the eminent engineer, was instructed to make a survey Nothing was done for six years, however, owing to the unemployment and financial complication that followed the close of the French wars, and it was not until 1818 that the question was revived at a public meeting in Stockton Town Hall, on July 31 At the meeting the Earl of Strathmore spoke in favour of a canal from Portrack to Evenwood, an undertaking estimated to cost £205,000 Leonard Raisbeck endeavoured to dissuade the meeting from pledging itself to the canal project and suggested a further inquiry as to whether it would not be better to use a railway at any rate for part of the distance. He was supported only by Edward Pease and Jonathan Backhouse, both of Darlington, who realized that the construction of the canal as proposed could not be satisfactory and determined to circumvent what they considered to be a disastrous proposal. As a matter of fact, the canal subsequently received very little financial support and probably would not have matured because of this

In the meantime Rennie had made his survey for the canal, and at a meeting in Darlington, held on September 4, 1818, it was decided to call for a survey for a railway for the whole distance between Stockton and the Bishop Auckland Collieries, and for a canal between Stockton and Darlington linked up to the collieries by a railway from Darlington. As a result of this George Overton, who had laid some seventy miles of small railways in South Wales, made a survey for the projected railway, and his report, together with Rennie's canal survey, was considered on November 13, 1818, at "a highly respectable meeting" in the Town Hall, Darlington.

After examining them the Committee decided

> that a rail or tramway throughout the entire line between Stockton and the collieries, with branches communicating with Piercebridge, Croft, and Yarm, is, under existing circumstances, preferable to a canal, that such a communication would be highly

> advantageous to the interests of the south and east parts of the county of Durham, and of Cleveland and other parts of the North Riding of Yorkshire, as well as profitable to those who engage in the undertaking; and that it is of importance to carry it into effect with as little delay as possible.

It was further agreed "That an application be made to Parliament for an Act for a tramway, on the plan and estimates given by Mr Overton."

Following this resolution, a meeting was held later in the year at Stockton, when it was decided that

> after carefully weighing all the information they possess, and availing themselves as far as they can of the calculations of the Darlington Committee, [those present had] no hesitation in deciding that the interests of the town of Stockton and of the country adjacent to the northern line, demand that a railroad should be constructed to enter the coal field at the nearest possible point.

This decision reached, some £22,900 was promised towards the construction of the railway, and a Bill was promoted and presented in 1819 It was opposed, however, chiefly by Lord Darlington (afterward Duke of Cleveland), of Raby Castle, over whose land the proposed line would pass, and it was defeated. Concessions were offered to Lord Darlington, but he was implacable, and on February 12, 1819, he wrote:

> Having long since been favoured with a similar permission to that which you now offer, I think it necessary only to add, that the measure you allude to appears to me now, as it has done before, to be harsh and oppressive, and injurious to the interests of the country through which it is intended that the railway shall pass.

The Committee therefore instructed another survey to be made, and this was carried out by Robert Stevenson,[1] of Edinburgh, an engineer famous for his construction of lighthouses

[1] No relation to George Stephenson.

As the result was still not acceptable to Lord Darlington and other landowners, a third survey was called for. This was made by George Overton, who in his report (submitted on September 29, 1820) concluded by saying: "Having had a further and better opportunity of viewing the adjacent country in every direction, the great utility of the undertaking appears to me still more manifest." Probably this opinion had a good deal to do with the removal of the opposition, which was withdrawn. A second Bill was prepared in 1820, but on January 29 the King (George III) died, and as Parliament would shortly be dissolved it was realized that it would be useless to submit the Bill at that time. The scheme was therefore deferred until the new session.

Again the company had to make a great fight, and every Member of Parliament and every peer who could be influenced directly or indirectly was pressed into service by the promoters. Their efforts were successful, and the Bill was passed by both Houses, receiving the Royal Assent on April 19, 1821.

It must be mentioned that nowhere in the Act is there any mention of locomotives or engines, the promoters simply obtaining power to develop and use the method of transport that, as we have already seen, had been used for over a century for carrying coals from the collieries to the Tyne. It is important to remember that even at this stage of development locomotives were not contemplated or even associated with the railway, either by the public, by the promoters of the 1821 Act, or by the engineers Overton and Stevenson, who made the necessary surveys. The proposed railway was "for hauling or drawing of wagons and other carriages passing upon the said railway or tramroads, with men or horses, or otherwise" It is clear that the "otherwise" was not intended to include steam-engines, because on May 23, 1823, another Act was obtained, giving power to "make, erect, and set up one permanent or fixed steam-engine, or other proper machine." This Act further allowed the making and use of "locomotives

or moving engines, for the purpose of facilitating the transport, conveyance, and carriage of goods, merchandise, and other articles and things, upon and along the same roads, and for the conveyance of passengers upon and along the same roads."

Before passing on to our next chapter we may mention that, although the Stockton and Darlington Railway was the first public railway on which locomotives were used, and the first to have the necessary powers to use them to transport passengers, no less than twenty-three Acts for making railways or horse-tramways had been obtained before it was incorporated. The first Public Railway Act was obtained in 1801 for the Surrey Iron Railway, extending for 9½ miles from the river Thames at Wandsworth by way of Mitcham to Croydon, with a branch of 1½ miles to Carshalton. This railway transported mainly agricultural produce, lime, chalk, etc , to London, and coals and manure from London It was opened in 1805 and was worked until 1846, when the company was dissolved.

CHAPTER X

THE COMING OF THE RAILWAY

As we have seen in the previous chapter, one of the chief promoters of the movement that resulted in the passing of the Act which authorized the construction of the Stockton and Darlington Railway was Edward Pease, of Darlington. Soon after the Act had been passed Pease met George Stephenson, who—as we have mentioned—had already built locomotives for Killingworth Colliery. At that time Stephenson was busy laying the Hetton Colliery Railway—a line about eight miles in length—through difficult country. His name must have been well known to Pease not only on this account, but also because he had patented several improvements in permanent way and rolling-stock. Then, again, application had been made to him to survey a line from the collieries in the Auckland district to Darlington some time before. All this is of some interest because there is a story—probably without foundation—that Stephenson heard of the promotion of the Stockton and Darlington Railway and tramped, with his bundle on his back, from Newcastle to Darlington to see Pease and to offer his services in the construction of the railway

Stephenson's first visit to Pease took place on April 19, 1821.

The result of this meeting was that, on January 22, 1822, Stephenson was appointed engineer to the Stockton and Darlington Railway. On May 23 the first rail of the new line was laid amid considerable rejoicing.

In regard to the question of motive power on the new railway, Pease was strongly in favour of the wagons being drawn by horses. Stephenson, however, was naturally in favour of the locomotive, which he said was worth fifty horses This

assertion resulted in Pease's agreeing to inspect Stephenson's locomotive at Killingworth, where it was then at work The outcome of this visit was that he and his cousin (Richardson) joined in partnership with Stephenson in establishing the locomotive works of Robert Stephenson and Co at Forth Street, Newcastle-on-Tyne After a discussion on the relative merits of locomotives and horses the committee ordered (on September 16, 1824) two locomotive engines at a cost of £500 each. One of these engines was the famous *Locomotion*—now to be seen on the platform at Darlington station—and the other was named *Hope*

The construction of the Stockton and Darlington line was not easy, for the country through which it passed was uneven There was also a high ridge, called Brusselton Hill, over which the line had to pass on its way from the collieries in the Auckland Valley. Stephenson urged the work forward, however, frequently reporting progress to the shareholders, and at last it was completed

On the day of the opening ceremony—according to Michael Heavisides, the local historian—the morning

> broke bright and fine, but, long before the sun rose, people were making their way from all parts of the compass to Brusselton near to West Auckland The scene surpassed anything that had ever occurred in that district before. Carriages, post-chaises, gigs, jaunting cars, wagons, carts, with equestrians, and a vast concourse of pedestrians—all pressed forward eager to behold a sight altogether new in that part of the country.

Locomotion, the centre of an admiring crowd, was getting up steam, and about ten o'clock the train was made up in the following order: the Company's locomotive engine; the engine's tender, with water and coals; five wagons, laden with coals and passengers; one wagon, laden with flour and passengers; one wagon, containing surveyors, engineers, etc ; the *Experiment*, containing the committee and other proprietors; six wagons, with strangers seated; fourteen wagons,

with workmen and others standing; six wagons, laden with coals and passengers.

Stephenson and his brother James were on the engine, and, the "All right!" having been given, steam was turned on, and, to the amazement of the assembly, the train of thirty-eight carriages, weighing in all over 80 tons, moved off. The scene is thus described by an eyewitness:

> The scene on the morning of the procession sets description at defiance. The welkin rang with loud huzzas As soon as it got fairly away, the crowd broke up, and ran as fast as it could after the train Gentlemen riding hunters, which, perhaps, were to meet Lord Darlington's foxhounds at this very place a fortnight afterwards, rode alongside the railway across the country, and for a time they managed to keep up with her, but it was not for long. The engine, running down a smooth line, with gradients in her favour, soon distanced the riders across country, and left the pedestrian multitude far behind [1]

At midday the train drew up at Darlington, where a great concourse of people were awaiting its arrival. The wagon-loads of coal were distributed among the poor of the town, and "two additional wagons, containing Mr Meynell's band, were attached in rear of the company's coach, playing at intervals cheering and appropriate airs." [2]

Locomotion having filled up with water, the train started for Stockton again with passengers hanging on to the wagons in every possible way. "All along the line the route of fields, lanes, and bridges were covered with spectators; and when the procession arrived within a few miles of Stockton, it was joined by a large number of horses, vehicles, and foot-passengers." [3]

At Yarm the crowds were dense, for here, as at Stockton, there was a general holiday, and the populace turned out to welcome the train. As the train approached Stockton, carrying some seven hundred passengers, there passed along the

[1] Quoted in *The Centenary of Railways*, 1825–1925, p 62.
[2] *Jubilee Memorial of the Railway System*, p. 70. [3] *Ibid*, p 71

turnpike road, in full view of crowds lining the railway, the stage-coach for Stockton, drawn by four horses and carrying sixteen passengers. At this point the road and the rail run parallel for some distance, and for a few minutes the rivals, the stage-coach and the railway train, ran side by side The past and the future were brought face to face, and no one who saw the seven hundred on the train, and the sixteen on the coach, doubted that the stage-coach had met its doom "On reaching the company's wharf a salute of twenty-one guns was fired, the band striking up *God save the King*, which was followed by three times three stentorian cheers"[1]

We have already mentioned that the Stockton and Darlington Railway was conceived for the purpose of transporting coal from the Auckland mines to Stockton for shipment, and that passenger traffic did not enter into the calculation of the proprietors In the first place, only a very few people travelled any distance from their homes in those days—indeed, between Darlington and Stockton there was scarcely enough passenger traffic to afford a profitable return to the owner of the coach that ran three times a week on the regular turnpike road It was the calculated opinion of such men as Nicholas Wood, George Stephenson's Killingworth friend and adviser, that for anyone to contemplate travelling on a railway at the rate of eighteen or twenty miles an hour was a ridiculous expectation The proprietors had no hesitation, therefore, in allowing privately owned coaches drawn by horses to be run on the railway under special arrangements. These privately owned coaches began to do an increasing business in passenger traffic, however, and on October 7, 1825, the company applied for a magistrates' licence to run a passenger-coach on the line From this fact it would appear that when the line was opened for traffic on the 27th of the preceding month the company had no authority to make use of coaches.

On October 10 the company's coach *Experiment* com-

[1] *Jubilee Memorial of the Railway System*, p 70

menced to run regularly between Stockton and Darlington According to a contemporary account, the *Experiment*—the coach included in the procession on the opening day—was "fitted up on the principle of what are called long coaches, the passengers sitting face to face along the sides of it, and calculated to carry 16 or 18 inside." In Longstaffe's *History of Darlington* a journey in this coach has been described for us by one of the earliest passengers between Stockton and Darlington:

> The coach had no springs of any kind, and yet the motion was fully as easy as in any coach on the road A very slight jolt is felt, accompanied with a click or rattle, every time the wheels pass over the joints of the several rails, and also at the breaks which occur at the different passing places, and these, if anything, feel harsher than in a coach. At any bends of the road, or other places where the view is obstructed, the coachman blows a horn to give warning of his approach to any wagons or vehicles that may be coming or going on the way. Some parts of the way were laid with rails of cast iron, joined at every four feet, and in coming upon these, the jerks and jolts were more frequent, more audible, and more sensibly resembling, exactly as the coachman justly observed to us, the clinking of a mill hopper.

The privately owned coaches continued to run on the railway until 1833, when the company bought them out. In the following year the company announced its intention of running coaches and carriages drawn by locomotives for the conveyance of passengers This came about as follows. Up to this time horses only had been used for drawing the passenger-coaches, but about 1833, when the company determined to take over the coaches, it was decided to use locomotives for this purpose The company built a new coach, the *Union*, and this, along with other second-class coaches, was placed in service toward the end of 1833. The fare was 1*s*. 6*d* inside and 1*s*. outside from Stockton to Darlington. Later in the year the predecessors of our present-day first-class coaches were introduced, when the company recommended 'that

two of the coaches lately purchased be put on springs, kept clean and neat, and charged 2*s.* inside and 1*s.* outside, to accompany each train."

On April 7, 1834, the company announced that it had commenced running coaches and carriages by locomotives for the conveyance of passengers and goods between Stockton and Middlesbrough "six times per day at present fares, thus forming a regular line of communication *via* Stockton and Darlington with Shildon, Auckland, etc"

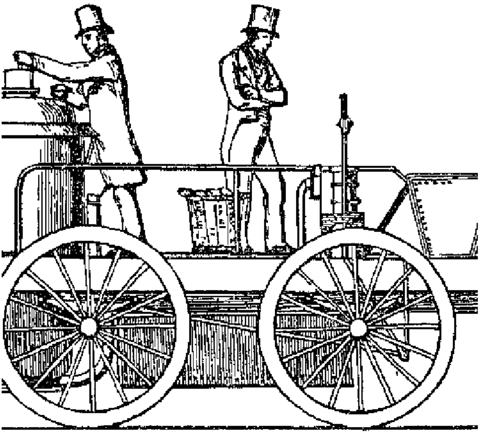
The Stockton and Darlington Railway was soon followed by the projection of the Liverpool and Manchester Railway. When the Bill came before Parliament there was considerable opposition, mostly from landowners, stage-coach owners, and other interested parties, who believed that the development of the railway would necessarily mean a serious financial loss to them. Pamphlets were written and newspapers were hired to revile the railway Some of the arguments advanced against it were highly amusing—as, for instance, the statement that the railway would prevent cows grazing and hens laying; that the poisoned air from the locomotives would kill birds as they flew over them, and would render impossible the preservation not only of pheasants, but also of foxes. Householders were warned that their houses would be burned by the fire thrown from engine-chimneys, and it was confidently predicted that the air for miles around would be polluted by the clouds of smoke. As the introduction of locomotives would result in there being no longer any use for horses, the species would become extinct, and therefore oats and hay would be rendered unsaleable commodities Not only would travelling by rail be highly dangerous—boilers would burst and blow passengers to atoms—but all the country inns would be ruined. After this fearful tirade it is disarming to find the final argument to be that, as the weight of the locomotives would completely prevent them from moving along the rails, the railways could never be worked by steam-power!

Strangely enough, this opposition to the railways did not diminish with time, for, even ten years after the Bill for the Liverpool and Manchester Railway had been passed and at a time when the Great Western Railway was projected, very similar arguments were advanced—this time by learned counsel. It was argued that, as the construction of the Great Western Railway would cause the course of the Thames to be choked up with weed—for the want of traffic to keep the river clear—the drainage of the country would be destroyed, and Windsor Castle would be left unsupplied with water. As for Eton College, counsel argued, it would be absolutely and entirely ruined, for the inhabitants of London would pour forth by railways and pollute the minds of the scholars. Even if this did not happen, the boys themselves would take advantage of the speedy means of travel and would be able to run up to town and mix with all the undesirables of London life, returning before their absence was discovered!

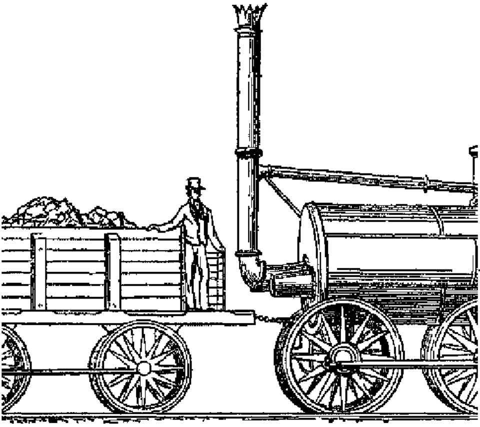
In the middle of 1824, while still at work on the construction of the Stockton and Darlington Railway, Stephenson was appointed engineer to the Liverpool and Manchester Railway, which was at that time being projected. When he began work on the railway he found that one of the greatest obstacles he had to overcome was the carrying of the line over a great peat bog, called Chat Moss, on the right bank of the river Irwell. The bog was some twelve miles square and was composed of a mass of vegetation, the growth and decay of ages. It was impossible for a man to walk across the bog or even to stand on it, yet it was necessary to construct a railway capable of supporting locomotives with heavy trains of passengers and goods. The opponents of the Bill were not slow to throw ridicule on Stephenson's plan to cross Chat Moss. Eminent engineers, called as expert witnesses by the opposition, stated that in their opinion no railway could be carried across the moss—they even declared the task to be impossible and that, therefore, no man in his senses would undertake it!

Stephenson, remembering that snow-shoes distribute a man's weight over an area much greater than that occupied by his feet and thus prevent him sinking into the snow, determined to work on similar lines. His idea was that a platform of sleepers could be supported by large quantities of heath and branches, so that the track in effect would be a floating road or elongated raft over the bog. This scheme was put into practice, and at the Manchester end thousands of loads of heather, branches, and turf were spread to form a pathway across the bog. The embankment had no sooner reached a height of a few feet than time after time it sank out of sight, leaving no trace behind. Stephenson persevered, however, never doubting the ultimate success of his plan At length his optimism was rewarded, and the bank gradually rose above the surface. Chat Moss was vanquished, and on New Year's Day 1830 the famous *Rocket* hauled the first train across. It is interesting to mention that the principles that Stephenson employed in overcoming this obstacle were subsequently used in many other parts of the world in the conquest of bogs and morasses.

In the case of the Liverpool and Manchester Railway it was by no means certain in 1829 that locomotives would be employed, even though the construction of the line had been in hand for three years. Repeated experiments had been carried out to establish the relative cost of horses and locomotives on the Stockton and Darlington Railway, and all had resulted in favour of the locomotive. An elaborate series of trials, made in the early part of 1829, showed that the cost of carrying 4263 tons by horses was £163, whereas by the locomotive the carriage of the same tonnage cost only £70. Stephenson, of course, was under no misapprehension as to the most effective motive power to be used, and he constantly urged his directors to adopt the locomotive. As a result of his endeavours they decided to hold a competition, offering £500 for the best locomotive to conform to certain specified conditions. The



"NOVELTY," AN UNSUCCESSFUL COMPETITOR IN THE RAINI



G 27. THE "SANS PAREIL," BUILT BY TIMOTHY HACKWORT

famous trials held at Rainhill, near Liverpool, in 1829 were the result, the story of which has been told elsewhere [1] The victory of the Stephensons' *Rocket* (Plate XVI, *B*) definitely proved the suitability of the steam locomotive, not only for the Liverpool and Manchester Railway, but, what was of even greater importance, for railway haulage in general

We do not intend to describe the evolution of the world's railways—such a story would occupy more than a single volume Suffice it to say that George Stephenson correctly prophesied when he said:

> I think you will live to see the day . . when railways will come to supersede all other methods of conveyance in this country —when mail coaches will go by railway, and railroads will become the great highway for the king and all his subjects. The time is coming when it will be cheaper for a working man to travel on a railway than to walk on foot. I know there are great and almost insurmountable difficulties that will have to be encountered, but what I have said will come to pass as sure as you live [2]

So popular had railways and locomotives become by the year 1846 that no less than 272 Acts of Parliament were passed for the construction of 4600 miles of new railroads in various parts of England in that year. Year by year additional companies continued to be formed, and thousands of miles of new lines laid, until to-day the four great groups (excluding the Metropolitan and London Tube Railways) have a total track mileage of 35,450 miles, and with sidings 51,000 miles.

The introduction of the locomotive probably had greater and more far-reaching consequences than any other development of transport, excepting only, perhaps, the invention of the wheel. While other developments have more strongly influenced social life the railway effected a complete revolution in everyday habits.

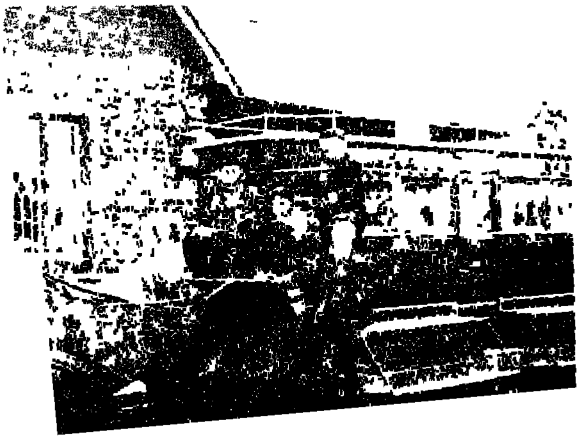
So far as Great Britain is concerned, the great influence

[1] See, for instance, the author's *Engineering for Boys* (T C. and E. C. Jack, 6*s*)

[2] Smiles, *Lives of the Engineers*, vol. iii, p 167.

A 'HORSE-POWER'

[illegible] railways depended for their power on horses. The horse hauled the wagons up inclines and rode back in a 'dandy'



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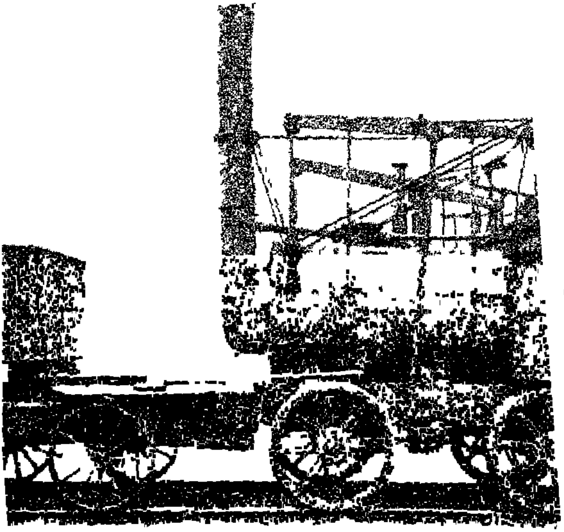


FFING BILLY,' BUILT BY WILLIAM HEDLEY IN 1
WYLAM COLLIERY

Photo Science Museum, South Kensington

exercised by the railways cannot be over-emphasized. So much has been said and written during the past few years about the wonders of transport by air and by road, that some people have gained the impression that railways will be superseded We must realize, however, that railways throughout the world were never so important as they are to-day, and they are likely to remain by far the most important form of transport for many years to come.

To-day British railways are more virile than they have been for many years past. By their handling of their new road powers, they have shown the vast improvements they are making on their own systems. By their anticipation of rail-cum-aerial transport, and by the powers they have now secured, they have shown that they can adapt themselves to modern conditions of trade and travel.

In September 1929 the Government set up a committee under Lord Weir to examine the economic and other aspects of the electrification of the railway systems in Great Britain, with particular reference to main-line working The report of the committee (issued April 1931) is in favour of a comprehensive electrification including all the present non-electrified lines except certain branch lines that might be more economically operated by independent haulage units. The report refers to the favourable results of the electrification already carried out on British suburban lines, and states that this success presents certain apparent considerations in favour of electric haulage for main lines. Since then much progress in this direction has been made, particularly on the Southern Railway.

CHAPTER XI

MECHANICAL ROAD TRANSPORT · FROM STEAM CARRIAGE TO MOTOR-CYCLE

THE introduction of the self-propelled vehicle completed the last of three revolutions in transport that swept over England and had a marked effect on the life of the people. The first began with the introduction of the turnpike roads that ushered in the coaching age. It was followed by the railways, which spread their network over the country with the inevitable result that the roads fell into decline. Now, over a century later, the roads have 'come into their own' again, and the petrol motor is challenging the sovereignty of the railways. It is difficult for us to realize the enormous change that has taken place in the traffic of our roads in comparatively recent years Even as late as 1900 the motor-car was almost unheard of, the appearance of a self-propelled vehicle in the streets being the occasion of so much curiosity that a crowd immediately collected. The story of the motor-car is an amazing one, and really is of sufficient importance to warrant more space than we can devote to it in this volume. As it is, we can but briefly outline the stages of its evolution.

The earliest mechanical contrivances to run on the road were propelled by steam The first of these, constructed in Paris in 1769 by Nicholas Joseph Cugnot, was a cumbersome vehicle (Fig. 28) which succeeded in attaining a speed of 2¼ miles an hour with four passengers The supply of steam lasted only some fifteen minutes, however, when the passengers were obliged to dismount and wait until the boiler had been replenished with water, and steam again raised The results interested the French Government, and an engine was ordered,

the intention being to use it for the transport of artillery The machine was to be capable of carrying a load of $4\frac{1}{2}$ tons at a speed of $2\frac{1}{4}$ miles an hour on level ground. The engine was made in 1770, but when it was tried in the streets of Paris it was considered to be a public danger and was locked up in the Arsenal. It is now exhibited in the Museum of Arts and Crafts at Paris. It consists of a heavy timber frame on three

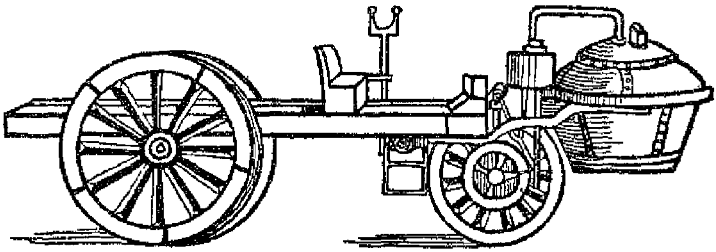


FIG 28. CUGNOT'S STEAM CARRIAGE

wheels, with a copper boiler in front. The front wheel has a broad and roughened tyre, and is driven by two inverted cylinders.

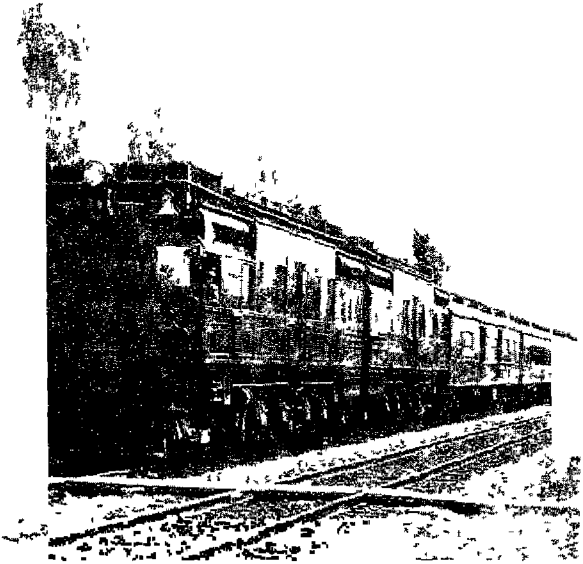
Other power vehicles were subsequently suggested or produced at various times. James Watt included a steam carriage in his patent of 1784. Murdock built some small models of locomotives about 1786. He was then at Redruth, where he was erecting some pumping-engines for Boulton and Watt. In August 1786 the firm's agent wrote. "Wm Murdock desired me to inform you that he has made a small engine of $\frac{3}{4}$ in. diameter and $1\frac{1}{4}$ in. stroke that he has apply'd to a small carriage, which answers amazingly." Murdock seems to have constructed three of these steam carriages, the last being of considerable size. Trevithick, who made small steam carriages about 1797, might have accomplished great things if he had persisted He constructed a full-sized vehicle in 1801, and successfully tried it on the road at Camborne in that year.

It is believed to have weighed about 1½ tons and to have travelled at speeds up to 9 miles an hour. In 1803 Trevithick made the first steam carriage to travel faster than any horse-drawn vehicle This steam road-coach was tried in the streets of London, but few particulars are available. It is interesting to note that a patent taken out by Trevithick shows clearly that he had conceived the idea of a gear-box for varying the speed

The first great development of road-carriages on anything like a commercial scale took place about 1830, when Mr (afterward Sir) Goldsworthy Gurney's steam carriages were used with considerable success on the roads in the south and west of England. Gurney was born on February 14, 1793, at Treator, near Padstow, in Cornwall. Little is known of his youth except that he received his education at Truro Grammar School. At the age of ten he was sent on holiday to Camborne, where he had the good fortune to see Richard Trevithick experimenting with his newly invented passenger-carrying locomotive Trevithick, who had been greatly interested in a model locomotive made by Murdock, was convinced that great possibilities awaited the invention of a satisfactory steam road-carriage. At Camborne, assisted by a relative named Andrew Vivian, he quietly set about constructing the vehicle we have already mentioned, and it was the result of this effort that Gurney saw being tried out. In order to appreciate the value of Gurney's work, we must remember that at the time of his boyhood railways were quite unknown; that in Cornwall even stage-coaches were seldom seen—for there were few roads in the county fit to carry them; that Watt's steam pumping-engines were by then well established in the tin-mines, and that a sensation had been created at Redruth in 1794 when William Murdock successfully lighted his lodgings with coal-gas.

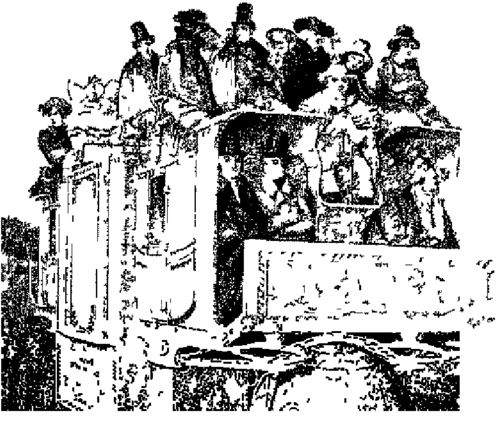
Two years later Gurney completed a steam carriage capable of carrying eighteen passengers Six rode inside and twelve outside, the latter being accommodated on two seats before and two behind the coach-like interior. At the back were the

MODERN EXPRESS THE "GOLDEN ARROW LIMITED
UTHERN RAILWAY, EN ROUTE TO DOVER FROM VIC
Photo Railway Photographs, Liverpool



B. THE LOCOMOTIVE OF THE FUTURE?
ll electric of the Canadian National Railways hauling the "Internationa

A GURNEY'S STEAM CARRIAGE (1825)



flues, from which, it was claimed, there would be no smoke, as coke or charcoal would be burned. The driver, or, as he is described in a contemporary account, "the Guide or Engineer," was seated in front.

> having a lever rod from the two guide wheels to turn and direct the carriage Another at his right hand connects with the main steam pipe by which he regulates the motion of the vehicle The hind part of the coach contains the machinery for producing the steam, on a novel and secure principle, which is conveyed by pipes to the cylinders beneath, and by its action on the hind wheels sets the carriage in motion.

The vehicle resembled the ordinary stage-coach of the day, but was rather larger and higher. The length was 15 feet, but in front of the driver projected a 5-foot pole with two pilot-wheels 3 feet in diameter. The vehicle, which weighed about 2 tons, carried a supply of fuel and 60 gallons of water, sufficient for one hour's consumption, in a tank under the body of the coach and extending its full length and breadth. The engine was of 12 h p., and the speed attained was about ten miles an hour. A brake was fitted on the hind wheels, and the motion of the wheels could be reversed to stop the vehicle instantly. The total weight was 1½ tons, and the wear and tear on the roads was estimated to be one-sixth that of a coach drawn by four horses.

Superheated steam was supplied to two cylinders, which were fixed below the body and drove the rear wheels The boiler had forty welded iron pipes arranged in horse-shoe form, the idea being that if one of these pipes should burst there would be no danger to the passengers, and the carriage could proceed with a loss of only a fortieth of the power

It should be mentioned that Gurney was not the inventor of the tubular principle for boilers, for over twenty years earlier Arthur Woolf patented a tubular boiler that proved very successful in Cornish mines. Trevithick, in a patent of 1815, appears to have considered the employment of a boiler of

this nature, although apparently no locomotive was ever constructed according to this patent Great credit is due to Gurney for the application of the tubular principle in his boiler.

Up to a certain point Gurney's road-carriages were successful, and they were often to be seen steaming along the highways about London. The War Office became interested, and at their request Gurney made a journey from London to Bath and back (on July 28, 1829), when he succeeded in maintaining an average speed of fifteen miles an hour. One of his passengers wrote:

> The success of the trial much exceeds whatever could have been anticipated by the most sanguine friends of the invention Hills were ascended and descended with the greatest facility and safety Marlborough Hill, the ascending of which it was thought would put the powers of the carriage to a severe test, appeared to afford not the slightest obstacle. As to the manageability of the machine, it far surpassed that of horses, or, indeed, any idea that could be formed of it.

This trip was the first long journey to be made at sustained speed by a locomotive on the high road, and it proved beyond doubt the possibilities of the invention.

Gurney's steam carriages created such a sensation that after witnessing trials at Hounslow Barracks the Duke of Wellington (then Commander-in-Chief of the Army) declared that they were "of great national importance," and remarked that "it is scarcely possible to calculate the benefits we shall derive from the introduction of such an invention." In these trials the vehicle carried a load of water and coke, weighing about a ton, and three men, also hauling a wagon containing twenty-seven soldiers. Its speed was about ten miles an hour, but without the wagon the carriage could travel at twice this speed. The merits and demerits of this type of locomotion were vigorously debated by scientists, and were the principal subject of conversation in West End clubs and country inns. The newspapers published columns about the invention, and coloured

lithographs depicting the carriages in all their glory of varnish and painted iron sold like hot cakes at the London print-sellers

About this time there was a remarkable outburst of prejudice among the uneducated workers against machinery of any kind Their argument was that the introduction of machinery meant less work for them, and they took every opportunity of smashing such machinery as they could lay their hands on. For some extraordinary reason Gurney's steam carriage aroused the bitter hatred of the agricultural community It is difficult to understand what damage they thought it was going to do to them, but apparently the mere fact that it was 'machinery' was sufficient On one occasion a massed attack was made upon Gurney's vehicle, and its occupants were stoned and beaten, the inventor himself being so badly knocked about that he lost consciousness for a time In the words of one of the passengers, "We were attacked by some brutal fellows, who, absurdly enough, imagined we were come to take the bread out of their mouths." The party were so unnerved by this experience that Gurney hired horses to tow the machine into Bath. On leaving there a few days later on the return journey horses were again hired, and steam was not raised until after Melksham, whence the eighty-five miles to London were completed within twelve hours, notwithstanding delays occasioned by difficulties in obtaining charcoal and water

Opposition of this kind had no effect upon Gurney, however, and he continued to develop and improve his carriage. Despite much opposition and prejudice he managed to establish services that ran from London to Liverpool, Manchester, Brighton, Southampton, and Holyhead But the turnpike trustees raised their tolls against the steam coach, and thus handicapped the new mechanical form of transport Tolls between Liverpool and Prescot, amounting to 4*s*. for a horsed coach, became £2 8*s* for a steam carriage, and between Ash-

burton and Totnes the 3*s*. toll for a stage-coach was increased to £2 On other roads the exaction was even higher.

In 1831 several of Gurney's steam carriages were taken over and improved by Sir Charles Dance, who, for some months, ran a regular service four times a day between Gloucester and Cheltenham, a distance of about nine miles. Although at first the service was profitable, it later ceased to pay because of the imposition of utterly prohibitive tolls, equal in some cases to half the working expenses. This crushing legislation against all road vehicles was apparently instigated by influential people who were interested in the future of rail locomotion and saw in the growing road traffic a serious rival.

The steam-coach proprietors determined to 'die fighting' and appealed to Parliament. A committee of the House of Commons was appointed in 1831 to inquire into the whole question of road carriages. The opponents of the steam carriages endeavoured to justify the heavy tolls by alleging that the carriages caused a considerable increase in the wear and tear of roads They also pointed out to the committee that the steam coaches might drive off the roads the post-chaises, stage-coaches, and other horse carriages that through the tolls contributed the chief part of their revenue

On the other hand, there was plenty of evidence that the steam coaches were efficient

> It was shown that steam coaches were then carrying passengers in various parts of the kingdom, that many more were being built for the same purpose, and that they succeeded in traversing "the worst and most hilly roads"; that an experimental carriage had run from London to Southampton, in some places at a speed of over thirty miles an hour, and had "ascended a hill rising one in six at sixteen miles an hour, and traversed four miles of road at the rate of twenty-four miles an hour loaded with people."[1]

So many witnesses were produced to give evidence of the

[1] Frederick Clifford, K C., *Private Bill Legislation*

success and value of steam coaches that the committee pronounced strongly in favour of every encouragement being given to Gurney and other inventors They declared the steam carriage to be "one of the most important improvements in the means of internal communication ever introduced" They were convinced that an average speed of ten miles an hour could be maintained by steam coaches conveying fourteen passengers, and that the coaches could "ascend and descend hills of considerable inclination with facility and safety." The report added that the weight of the coaches, with engine, water, fuel, and attendants, need not exceed three tons, denied that they need be a nuisance on the roads, and declared them "a speedier and cheaper mode of conveyance than carriages drawn by horses." They recommended, therefore, that more moderate tolls be substituted for those that were killing the new means of transport The opposing interests in Parliament rallied their forces, however, and proved strong enough to prevent action on the committee's recommendation.

Determined that the steam carriage should not be driven off the road, Gurney submitted to Parliament a personal petition for a further consideration of the situation. He succeeded in securing the appointment of another committee, who came to the same conclusion as the original committee They recommended that the ruinous toll charges should be withdrawn and that compensation should be paid to Gurney for the losses he had sustained through the operation of the Act. Nothing resulted from these suggestions, however, and Gurney in disgust put on one side the subject of steam carriages, devoting himself to matters financially less disastrous.

By the end of 1833 more than a dozen steam road vehicles were operating in the vicinity of London, but the heavy taxation that had driven Gurney out of the business gradually suppressed other venturesome spirits also In May 1836 Walter Hancock placed carriages on the Paddington Road,

where they ran regularly for over five months. In all they accomplished 4200 miles, consisting of 525 trips to Islington, 143 to Paddington, and 44 to Stratford. In 1838 he built a light steam phaeton for his own use, which travelled at a speed of 20 miles an hour, being driven about the city of London and manœuvred among horses and carriages without annoyance or danger. He finally withdrew his steam carriages from the road in 1835, after having achieved considerable success in running regular trips in the neighbourhood of London. By this time the railways were freely attracting capital, and they became the greatest opponents of the steam road vehicles, which were finally defeated and withdrew from the unequal contest. Thus the development of road traction and of the mechanically self-propelled vehicle received a setback of over half a century

In addition to the heavy tolls effectively killing the development of the steam road carriage, progress in regard to road transport in Britain was further impeded by the passing (in 1865) of an Act of Parliament restricting the speed of all mechanically propelled vehicles to a maximum of 4 miles an hour in the country and to 2 miles an hour in the towns. The drivers of all power vehicles were required to have a man walking in front with a red flag Moreover, such a vehicle had to be driven by not less than three persons. Because of these restrictions, mechanically propelled vehicles were of little importance until the invention of the internal-combustion engine, the idea of which is that the fuel provides power directly instead of through an intermediary as in the steam-engine. Strictly speaking, the first internal-combustion engine was the gun, in which pressure produced by the explosion of gunpowder was used to hurl a missile out of a cylindrical tube Suggestions for obtaining mechanical power by such explosions were made by various people, but all came to nothing until the discovery of a more suitable explosive than gunpowder—which was not a practicable fuel,

if only because of the difficulty of arranging the intermittent feeding of the fuel as required.

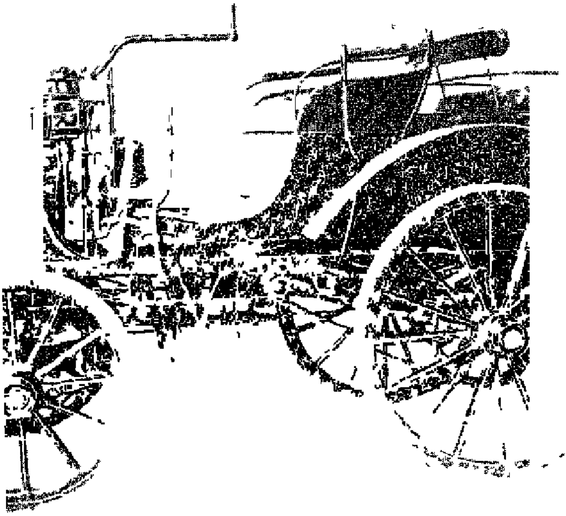
Before dealing with the petrol engine we must mention that in 1880 Amedée Bollée, of Le Mans, built a steam carriage, and in it travelled from Paris to Vienna. It had a vertical engine at the front, the drive being to a countershaft by means of shaft and bevel gears The final drive was by chains, and a differential gear was fitted. This carriage attained a speed of about 22 miles an hour on the level

In 1794 a suggestion for using inflammable gases was made by R Street, who pointed out that gaseous fuel is much more suitable than solid fuel for an internal-combustion engine Although a gas engine was actually constructed in 1823 by Samuel Brown, it was not until 1860 that a really successful engine of this type was produced by Lenoir. It worked in a somewhat similar manner to a steam engine, a mixture of gas and air being admitted by a valve for about half the stroke of the piston and fired by an electric spark immediately the valve closed The piston was returned by a similar explosion on the other side, and so swept the products of combustion out of the cylinder. There were thus two explosions to each revolution of the crank-shaft. Although Lenoir's engine had only a limited use because it was very wasteful, it introduced one important feature of the modern engine—the electrical method of starting combustion.

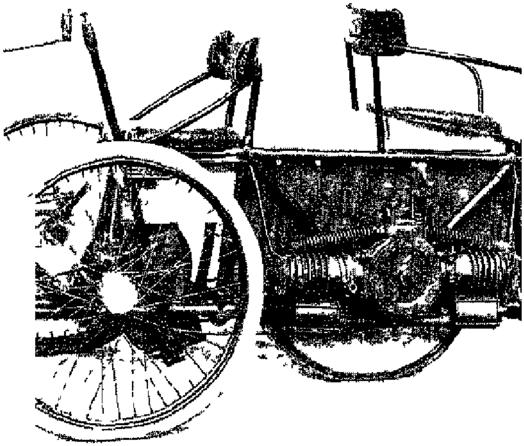
The chief defect of this early gas engine was that the mixture was not compressed before firing, although a suggestion that this should be done had been made as early as 1838 by W. Barnett. This advantage was not fully realized until 1862, when the theory of the modern internal-combustion engine was outlined by Beau de Rochas, a French engineer His plan was to have four different operations taking place during two revolutions of the crank-shaft The cylinder was open at the crank side, all the operations taking place on one side of the piston only. Each operation was controlled by one of the

four strokes of the piston in conjunction with two valves fitted to the cylinder head. The cycle of operations commences with the first stroke of the piston outward, which increases the available space in the cylinder, and the explosive mixture is drawn into it through one valve. This is compressed by the return stroke, at the end of which the mixture is ignited, so that the third stroke is the actual working stroke Finally, the next return stroke sweeps out the gaseous products of combustion through the second valve. It will be seen that power would only be communicated to the crank-shaft during one of the four strokes, and a fly-wheel was therefore necessary to maintain speed during the idle strokes. Successful engines working on coal-gas in accordance with this suggestion were designed a few years later by Otto, who is now famous as a pioneer of gas engines. The final step in the construction of an engine suitable for a road vehicle was made in 1884, by the famous engineer Gottlieb Daimler He had previously worked in Otto's factory, and, seeing the opening for a small engine of the Otto type to propel cycles, he designed and brought out a light, compact engine in which petrol vapour was used as fuel.

At this point we may usefully include a brief reference to the bicycle, a mode of individual transport that has been popular for many years Although pedal-operated carriages were known in the Middle Ages (during the seventeenth and eighteenth centuries many light vehicles of this type were introduced), the earliest form of the bicycle was the 'hobby-horse,' or 'dandy-horse,' as it was sometimes called. This consisted of two wheels mounted in a kind of frame with a saddle for the rider, who was seated sufficiently low to be able to propel the vehicle forward by striking his feet on the ground The earliest machines of this kind were is use about 1810, but their riders were so ridiculed that 'hobby-horses' went out of use In 1818 an improved form was patented by Baron von Drais in France, and brought over to England in the same year by Denis Johnson, a coachmaker of Long Acre, who called it the

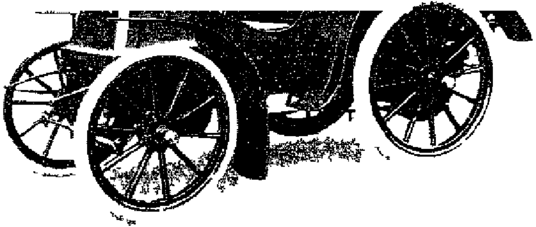
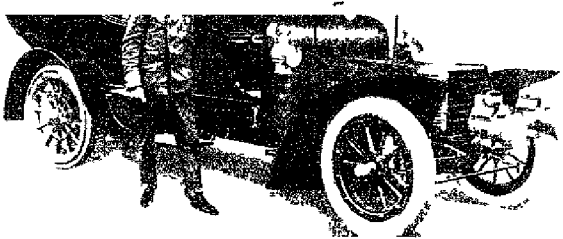


A EARLY PANHARD MOTOR-CAR OF 1894



B THE FIRST WOLSELEY CAR (1895)

Photo [illegible] *South Kensington*

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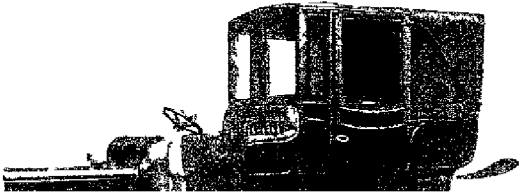



'pedestrian curricle.' It consisted of a wooden bar, or backbone, mounted on two wheels, the front one being pivoted in a fork to allow the machine to be steered and balanced. The machine was propelled by the rider leaning his elbows on a padded support, and alternately striking the road with his feet. In this way a speed of 10 miles an hour sometimes could be

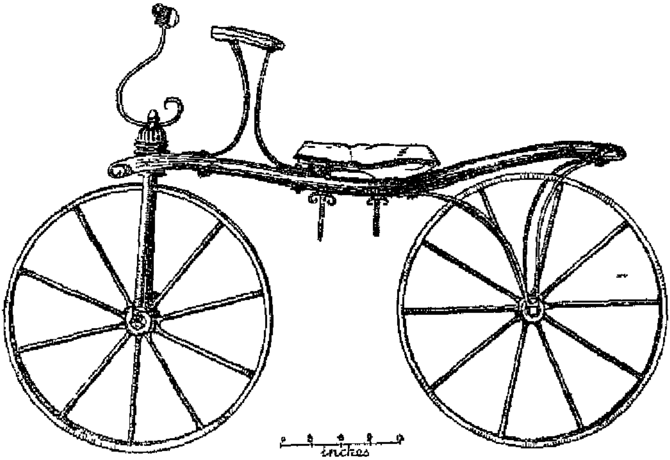


FIG 29. JOHNSON'S HOBBY-HORSE, 1818

maintained on the level. Riders generally 'coasted' down hills, but when a hill had to be ascended the machine was carried on the rider's shoulders! A hobby-horse weighed about 50 pounds and cost about £10.

In 1839 Kirkpatrick Macmillan, a blacksmith of Courthill, Dumfriesshire, fitted pedals and cranks to the rear wheel, but again the machine was a failure About 1864 Pierre Lallement, of Paris, adopted a front-wheel drive by fitting cranks and pedals, and, strange to say, this 'bone-shaker,' as it was called, became the first popular 'bicycle' (Fig 30) The backbone was of solid iron, and the wooden wheels had iron tyres. It was introduced into England in 1868, and large numbers

made and used. In 1869 wire-spoked wheels were intro- by E. A. Cowper, and in the following year solid r tyres, and ball-bearings in 1878.

order to obtain a greater rate of travel without having to ase the speed of pedalling, the front wheel was made

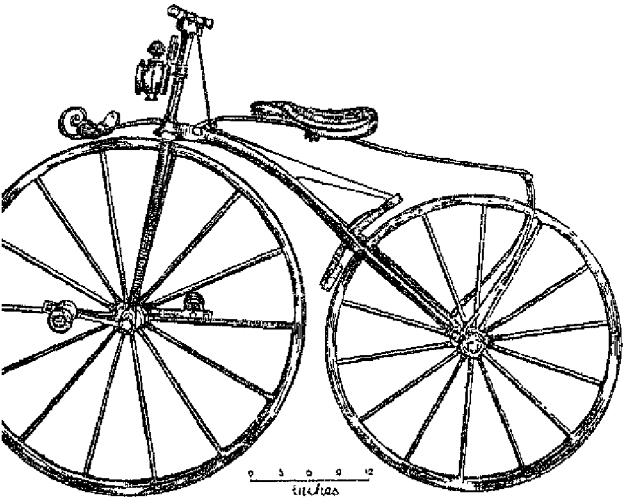


FIG 30 'BONE-SHAKER' BICYCLE, 1869

, and the size of this wheel gradually increased until it ately reached 5 feet or more (Fig. 31). These machines, were known as 'ordinaries,' were somewhat dangerous se of their liability to be easily upset on encountering comparatively small obstacle. Several attempts to pro- a safer bicycle were made, and in 1873–74 the modern of 'safety' bicycle with rear-chain drive, was introduced J. Lawson, of Brighton (Fig 32) Several designs of were tried before the present diamond frame was ed as standard about 1890. The early 'safeties' weighed 60 pounds, but later their weight was reduced by the steel tubing for the frame and forks and hollow rims

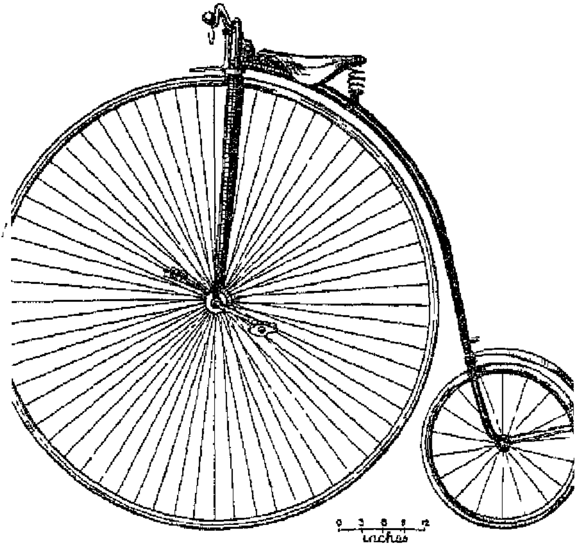


FIG 31 THE FAMOUS BEESTON HUMBER BICYCLE ORDINARY, 188

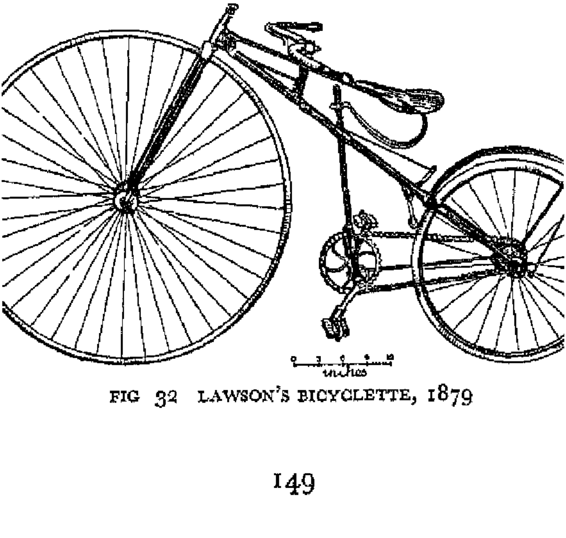


FIG 32 LAWSON'S BICYCLETTE, 1879

for the wheels. In 1888 Dunlop's pneumatic tyre began to replace the solid rubber or hollow cushion tyres of the earlier machines, and marked a great improvement.

Motor-cycles originated with the steam tricycle built in 1882 by Messrs de Dion and Bouton. In 1884 Gottlieb Daimler brought out his engine, to which we have already referred, and in the following year he built this engine into a bicycle It becomes rather difficult after this to distinguish motor-tricycles from motor-cars, for the first cars were really glorified tricycles which later developed into the four-wheeled motor-car.

CHAPTER XII

MECHANICAL ROAD TRANSPORT· FROM MOTOR-CAR TO TRACTOR

To return now to the story of the motor-car. As we have already mentioned, the authorities in Britain took a serious view of mechanically propelled road vehicles, and in view of the restrictions they imposed it is not surprising that the earliest steps in the further development of Daimler's idea were taken on the Continent Although the manufacture of motor vehicles began in Germany and France, where Benz and Panhard machines were the first to become prominent, it is almost certain that the first man to make a petrol car was Siegfried Narkus, in Austria He fixed a small petrol engine under a two-wheeled hand-cart and connected it to the axle on which two fly-wheels were mounted, steering the vehicle by a two-wheeled fore-carriage Because of the crowds who gathered to see it Narkus ran his car on the roads chiefly at night Eventually the police compelled him to discontinue his trials, however, as the crowds obstructed all other traffic!

Carl Benz, of Mannheim, built his first car in 1885 This notable vehicle was a two-seater, and had three wire wheels fitted with solid rubber tyres The engine was placed above the rear axle, and had one horizontal cylinder and a vertical crank-shaft. This drove a horizontal shaft through bevel gears, which was connected by a bolt with a shaft that had fast and loose pulleys mounted on it. The drive was finally transmitted to the rear wheels by sprockets and chains. The engine, rated at $\frac{3}{4}$ h.p., was supplied with explosive mixture by a surface carburetter and a mixing valve. Very crude though the car was in comparison with later developments, it

is noteworthy that its ignition was by coil and battery, a method that is universal in modern American cars. Subsequently Benz made other cars, and they did much to demonstrate the possibilities of the new form of locomotion. In general they were similar to the one already described; the influence of early carriage-building methods is to be seen on practically all of them—for example, the seating arrangements, leather hood, and large road-wheels As in the old horse-carriages, braking was accomplished by pressing wooden blocks on the tyres

Cars of a similar type were also being made in France, where the pioneers were Panhard and Levassor, who had acquired the French and Belgian patents for the Daimler engine. They soon developed features that distinguished their cars from those of Benz, and in 1888 they made over a hundred cars, fitted with light petrol engines.[1] By this time so many motor-cars were appearing in the neighbourhood of Paris that (in 1893) a police regulation was made, prohibiting any self-moving vehicle from travelling in the Department of the Seine at a greater speed than 12 kilometres (7½ miles) an hour in towns, and 20 kilometres (12½ miles) an hour in the country

In the meantime motor-cars in France had reached such a state of development that long-distance races were being organized. The story of these races well illustrates how rapidly the industry went ahead after it had once obtained a fair start In 1894 there was a trial run of motor-cars from Paris to Rouen Of the 192 cars entered, only twenty-one started, fourteen of which were petrol- and seven steam-driven All the starters finished with the exception of four of the steam-driven cars, the first to arrive being Count de Dion, whose steam car hauled an ordinary carriage Later de Dion became the maker of a famous petrol car, and steam cars never again proved superior

[1] It is interesting to note that the first motor-show was held at Tunbridge Wells in 1885, where there was exhibited a Panhard car, a De Dion steam motor-car, a Peugeot petrol-driven car, and a petrol-engined bicycle. In the trials that followed a speed of 8 miles an hour was reached by the winner!

to petrol cars in races In 1895 a race for motor-cars was held from Paris to Bordeaux (732 miles), and was won by Levassor on a 4-h.p. Panhard at an average speed of 15 miles an hour The last to arrive was a Bollée steam omnibus, ten years old!

An early example of the Panhard car was brought to England in 1895. It had a two-cylinder engine in practically the same position as the engine of modern cars. The cylinders were inclined at an angle of fifteen degrees to each other, and the pistons worked on the same crank-pin. The explosions occurred alternately, giving one working stroke in each revolution of the crank-shaft, instead of in two revolutions as in the single-cylinder engine The engine speed was 800 r p m , and it developed 4 h.p. The drive was taken through a friction-clutch, change-speed gear, and bevel-gearing, to a transverse shaft at the end of which were sprocket-wheels connected to the rear road-wheels by chains

It will be seen that in this car the number of cylinders had been increased and a clutch introduced. The clutch was of the leather-faced cone type, and was controlled by a pedal as in modern cars This was a great improvement on the fast-and-loose pulley method used in the Benz car The car also had a gear-box—it would be more accurate to say that it had the contents of the gear-box as we know it to-day, for the gear-wheels were not enclosed, the inventor believing that it was only a makeshift device for giving variable speed There were two shafts, one driven by the engine and the other connected to the driving-shaft, on each of which gear-wheels of different sizes were mounted They could be brought into mesh by the manipulation of a lever, but changing had to be done as the wheels were rotating. Great wear and tear resulted with the crudely cut gear-wheels then available, but the system was adopted for practically all cars and remains in use to-day.

One peculiarity of the Panhard-Levassor and certain other cars was the ignition system used The coil and battery did

not find favour with the French engineers, who used instead a hot tube in the cylinder wall. This tube was of platinum, closed at the outer end, and so situated that a portion of the explosive mixture was introduced into it at the moment when ignition was required. The tube, which was made red-hot by heating from the outside with a petrol flame, ignited the mixture when it came into contact with it, thereby exploding the entire charge

In Great Britain matters did not progress so rapidly as in France and Germany A motor-tricycle had been introduced by Edward Butler in 1887. This had two front wheels and a rear driving-wheel Its engine was of the compressionless type, with battery and coil ignition, and a radiator for cooling the water that circulated round the cylinders Butler's machine was to have been developed on a commercial scale, but unfortunately a close study of the red-flag law failed to disclose any method of circumventing it. A distinctive motor-cycle with a four-cylinder engine was patented by Colonel Holden in 1896

In 1895 J H Knight, a successful designer of gas engines, built a motor-car that ran well—indeed, it ran too well, for it ran him into trouble! Knight was fined for not having a traction-engine licence, and also for driving his car on the road without having a man in front with a red flag to give warning of the approach of the vehicle The same fate overtook several other daring spirits who brought Benz or Panhard cars to England and ventured on the roads with them. The prospect of vehicles careering along at the rate of 15 miles an hour—for such speeds were now possible—undoubtedly created some alarm Eventually, however, demonstrations of the docility of motor-cars, and a growing appreciation of the benefits likely to result from their development, led to the passing of an Act (in 1896) exempting certain vehicles—those weighing less than 3 tons when empty—from the 2- and 4-miles-an-hour speed limits For vehicles under 1½ tons a speed of 12 miles an

hour was allowed, heavier vehicles being required to travel at lower speeds In 1903 a further Act allowed vehicles of under 2 tons to travel at a maximum speed of 20 miles an hour, and proportionately higher speeds were allowed to heavier vehicles

By this time the general outlines of the motor-car had become established The principal features included multi-cylinder engines under bonnets in front of the cars; radiators either of the tube or honeycomb type, for cooling the water circulating round the cylinder heads; brakes, clutches, and change-speed gears (working in an oil bath in a gear-box) became standard fittings. Although at first the final drive to the rear wheels was still often by sprocket and chain, the floating axle with a bevel-drive soon came into favour. In addition, the body-work had changed considerably from the carriage type.

The pneumatic tyre was originally introduced (in 1888) for the bicycle, the use of which greatly increased during the years that followed as a result of the greater speed and comfort possible. The idea of using the tyre for motor-cars must have occurred to several pioneers, but possibly they were deterred by the weight of the vehicles concerned. It was left to two Frenchmen, the Michelin brothers, to decide that weight was no obstacle, and they attempted to persuade the makers of motor-cars to fit specially made pneumatic tyres. They did not meet with success, however, and in the end they bought a car themselves in order to give their ideas a practical test. They competed in the Paris-Bordeaux Race of 1895, and during the race (732 miles) used no fewer than twenty-two inner tubes! Two or three years later their ideas were completely vindicated, for by that time the solid tyres used on the early cars had given place to pneumatics.

The detachable rim was also suggested about this time, and the advantages to be derived from it were realized by all—and particularly by those who had had the unpleasant experience of

mending or changing tyres in bad weather It was not until 1906 that detachable rims came into general use, however, and at about the same time the Rudge-Whitworth detachable wheel was also introduced In later years this device not only added to the comfort of motoring, but played a great part in motor-racing, the speed with which wheel changes could be effected being astonishing.

Although motor-car bodies were now made lower and therefore were more suited to the nature of the vehicle and its speed, there was still no complete protection from inclement weather, except in the case of a few heavy and expensive cars. In those days no motorist was considered to be equipped unless enveloped in thick furs or leather coat and goggles, and even a short journey by road was an adventure.

As the main features of cars became standardized parts were better adapted to each other, and growing experience led to the use of better material The working parts thereby became more reliable, and improvement in design enabled reductions in weight to be effected without loss of strength In regard to the engine it became recognized that a more even torque (or 'turning-force') was obtainable with a multi-cylinder engine, and the use of four cylinders was common practice at a comparatively early date. In recent years this has been taken a step farther, and engines of six cylinders are now common, while those of eight or twelve are also in use Ignition methods changed from the use of coil and battery to the magneto, in which current is produced by rotating a coil in a magnetic field The ease with which current could thus be generated led to the introduction of the dynamo to generate current for lighting and later for starting the engine. Lighting previously had been by oil or acetylene lamps. Standardization led to mass production, and consequently reduced prices, with a corresponding increase in demand.

Every year the mechanically propelled road vehicle plays an increasingly important part in solving the transport problems

of the world. So far as Great Britain is concerned, enormous strides have been made in motor-transport during the past few years—first during the post-War period in the transport of freight, and later in passenger transport—and the motor-lorry and the motor-coach have become serious rivals to the railway, for a large part of the traffic of which they actively compete

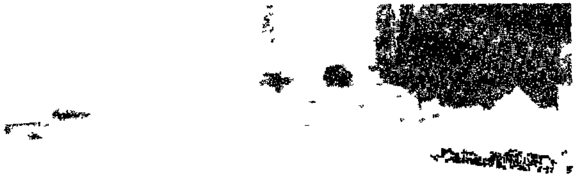
Much of the transport of Great Britain is carried by road—to mention only an instance, millions of tons of raw cotton are carried from Liverpool to Manchester every year, to say nothing of fruit and foodstuffs carried from ports to inland towns Even locomotives that are out of gauge for English railways are now being delivered to the dockside by road transport, a special sixteen-wheeled truck having recently been built by Messrs Scammell-Lorries, Ltd, London, for transporting locomotives from the works where they have been built to ports for shipment abroad In twelve months this firm of transport contractors delivered, on one order alone, 154 locomotives varying in weight from 56 to 97 tons from the works to port They also transported over hundreds of miles by road, *en route* for India, complete railway coaches that were too large to be transported by rail, numbers of 50-ton girders, and even tug-boats The same type of mammoth vehicle was used also for the road transport of many other large engineering structures—a giant rudder, constructed by the Darlington Forge for a big Canadian passenger steamer, was conveyed to the docks at Glasgow. (Previously giant forgings had been railed from the works to Middlesbrough Docks, a distance of 16 miles, for shipment to the required destination.) Another contract was the removal of a lathe weighing 250 tons, and measuring 74 feet in length by 17 feet in width, by road from Devon to the East Coast In the course of this transport, in order to pass abnormal loads under bridges, roads have been excavated and subsequently restored to their original state. Some boilers transported were too large to pass under bridges even in this way, the difficulty

being overcome by unloading and rolling the boilers under the bridges, reloading them on the other side.

Perhaps the greatest limitation to the use of wheels lies in the fact that, in order to support the load, the wheel must sink into the ground, producing the familiar effect of rutting and destruction of the surface. It is not generally recognized, however, how great is the increase in effort required to move a wheel which, on account of the weight imposed, has sunk into the ground. Because the ground surface may be generally level it is not realized by the casual observer that the wheel is being called upon, on account of its sinkage, to climb uphill all the time, the steepness of the gradient depending upon the depth of sinkage and the size of the wheel. The damage caused by the sinking of the wheel produces a steadily increasing deterioration of the surface, thus making transportation more and more difficult. A further limitation is the practical impossibility of building wheels of very large diameter.

In the attempt to reduce the difficulties arising from sinkage the first and most obvious course is to produce a hard surface for the wheels to run over. Hard and durable road surfaces have been evolved, but the cost of building and maintaining them is often out of proportion to the value in the saving of effort thus secured. As a result, even to-day it is only among highly civilized and wealthy communities that we find networks of good hard roads. Owing largely to the high first cost of paved surfaces early efforts in the direction of economy took the form of wooden runways of just sufficient width to support the wheels of the vehicles. As we have already seen, this led to the building of railways in which the wooden runways were replaced by metal rails. The success of these rails compelled people to recognize that railways are the cheapest method of land transport if sufficient traffic is available to keep them fully employed.

In the early days the cost of the rails was so high that it was generally considered impracticable to cover a country with an



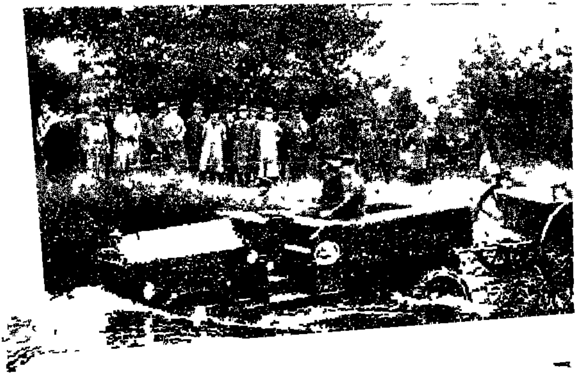
4 TRACTOR TRAINS IN THE SNOW, NORTHERN CA

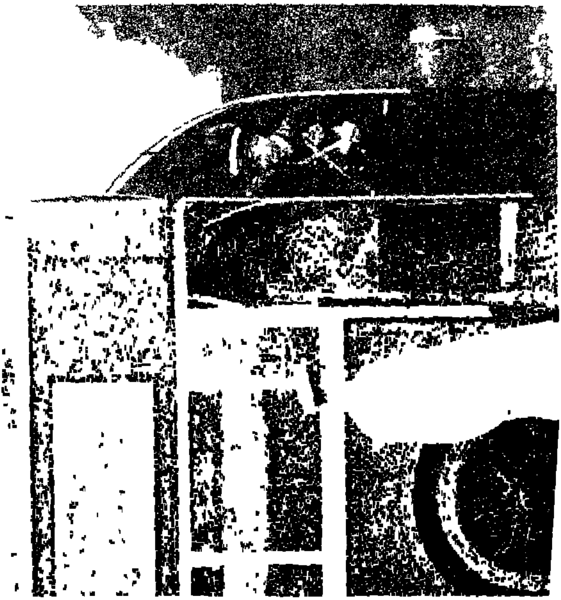
The one on the right is equipped with a snow plough

A FORDSON TRACTOR HAULING FELLED TIMBER I

THE FOREST

Photo Austin Motor Company, Ltd , Chelmsford





adequate network of lines to carry the necessary traffic. At that time no one could foresee the development that has taken place in the production of cheap steel, and in consequence machines were built that were capable of economizing in rails by lifting them up behind and laying them down again in front, while continuing to roll over them Clearly this could only be done by cutting up the rails into short lengths and jointing them, and in this manner originated what we now know as the endless-track, or 'caterpillar' type of vehicle (Plate XXI, *A*, *B*)

The earlier conventional types of endless-track vehicles were fitted with tracks the plates of which were coupled together by unlubricated and unprotected pin-joints. Steering was effected by slewing round the machine bodily, the endless track itself being laterally rigid and incapable of steering by laying itself in a curve. The defects of this type were many and serious, and experiments were commenced in several countries to invent a more satisfactory design In England considerable improvement was effected by Roadless Traction, Ltd., of Hounslow, through the use of a universally jointed, laterally flexible track, with a lubricated and protected pin-joint. Machines were produced capable of being worked continuously at speeds of from fifteen to twenty miles per hour There remained, however, the difficulty of insuring that users of these vehicles would attend properly to the lubrication of the pin-joints, and in addition there was no satisfactory means of excluding mud and grit from the joint. The obvious remedy was to produce a type of track-joint in which the pin, the main source of weakness and trouble, could be entirely eliminated. The possibilities of using rubber for a joint were investigated, but the preliminary experiments proved a failure Convinced that the solution of the problem was to be found in this direction, however, the firm returned to the attack and ultimately succeeded in producing a type of endless track in which the pin-joint is replaced by blocks of rubber in com-

pression, without any metallic contact between the plates forming the track. Lateral flexibility of the track to effect steerage has been preserved and is provided for by the rubber.

Roadless equipment of this type has been produced for a variety of vehicles, among the more interesting of which may be mentioned the new Fordson tractor (Plate XXI, *B*). The rubber-jointed track for this vehicle consists of a series of ground-shoes to which are fixed, through the medium of large-diameter split-pins, the driving-teeth that engage with the driving-sprocket The ends of the connecting links, or rolling-paths, are clamped firmly between rubber blocks in the ground-shoes in such a manner that all the movements between the rolling-paths and the ground-shoes are taken up by distortion of the rubber blocks, there being no metallic contact between the parts. All that is necessary in order to disconnect the track is to drive out the split-pins, thus freeing the driving-tooth from the ground-plate and releasing the rubber blocks and the rolling-paths.

The Fordson tractor thus equipped has a great draw-bar pull on account of the fact that, as the joint is practically frictionless, the engine-power can be used more effectively, and also on account of the exceptional anti-creep and ground-adhesive capacities resulting from the special construction of the rubber-jointed track. The track has a very long life because of the elimination of the wear and tear of pin-joints Transmission shock is largely eliminated by reason of the semi-elastic drive that the rubber joints provide, and the reduction of shock to the vehicle as a whole is further assisted by the fact that much of the weight of the machine is supported by the rubber blocks The Fordson Roadless tractor was put through a very severe test recently in hauling seaweed on the Margate sands The tractor hauled without difficulty a general service wagon laden with about 3 tons of wet seaweed, in spite of the fact that the wagon was fitted with ordinary wheels, which sank deeply into the sand.

Frost and snow provide difficult conditions for endless-track vehicles. If running ceases when pin-jointed tracks are coated thickly with mud, and this is then allowed to freeze, breakages almost invariably follow the attempt to commence running again before the frozen mud has been thawed. A notable example of this occurred with the tanks in France during the winter of 1916 For many weeks scores of tanks were immobilized on this account, the weather being so severe that any attempt to thaw out the tracks was ineffectual, while moving them without first thawing the mud simply resulted in breakages Tests made in the early part of 1930 in Russia with the Rushton Roadless tractor show that the rubber-jointed track is not liable to trouble from this cause These tests were carried out near Moscow for the Soviet Government, and the tractor was set to haul a load of 7½ tons over a great variety of ground surfaces. The elasticity of the joint prevented lodgment of snow on any part of the track where its presence would be of any importance, and the track was unaffected by frost

Another very interesting endless-track vehicle is the Citroën-Kégresse, which consists of a Citroen car fitted with the Kégresse-Hinstin endless-band driving attachment The drive is transmitted by means of a number of teeth spaced along each edge of the endless belt, which engage with lugs riveted to the driving-pulley rims. An absolutely positive drive is thus obtained, and complications of the cam-gear in the driving-pulleys are eliminated The constituent parts of the endless band—a main endless belt composed of rubber-coated canvas fabric, the central guide tongues, and the tread—instead of being moulded in one piece of rather complicated construction, are separate units, any of which can be renewed independently

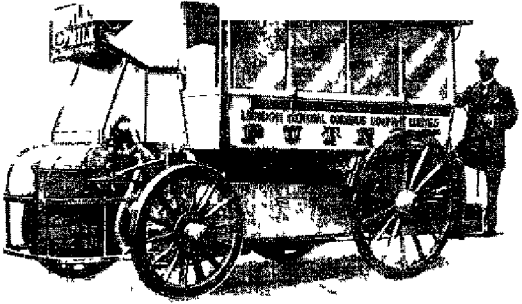
Citroen-Kégresse cars have accomplished many remarkable performances under conditions ranging from Alpine snows to desert sand. On December 17, 1922, five of these cars set out

from Touggourt and travelled across the Hoggar and the Tanezrouft, or "Land of Unquenchable Thirst," without following any beaten track or route taken previously by other expeditions or caravans They reached the river Niger at Bourem, and followed the river down to Timbuctoo, where they arrived on January 7, having covered 2000 miles in 22 days at an average rate of about 90 miles a day. Thus the cars had accomplished in three weeks a journey that takes a camel caravan six months. After staying a month in Timbuctoo the expedition commenced the return journey, which was accomplished successfully On another occasion a fleet of Citroen-Kégresse cars crossed the whole of Africa from Algeria to the Cape, carrying out on the way scientific researches of great importance

These journeys proved that endless-track vehicles are capable of negotiating without difficulty, and at a reasonable speed, country that is absolutely impassable to vehicles of the normal wheeled type. The adaptability of such vehicles is very remarkable, and it is this feature that makes them so valuable to the farmer A tractor fitted with endless track can be taken across water-logged ditches, over wet fields, and in fact any type of difficult ground, and it is always ready to haul, as required, any type of agricultural machinery.

The petrol-driven omnibus appeared in London about 1899, plying on the Kennington-Victoria route, and in the following year ran between Kennington and Oxford Circus. This pioneer was followed by others, the horse-omnibus companies meeting the situation as best they could. The Road Car Company adopted motor-traction on an extensive scale, but the London General Omnibus Company maintained the horse-drawn bus, although experimenting with motor-buses In 1908 the Road Car Company, as well as some smaller companies, was taken over by the L G.O.C., and the omnibus traffic of London was co-ordinated

In 1910 the L.G.O.C evolved the 'B' type omnibus (Plate


LONDON GENERAL OMNIBUS COMPANY LIMITED

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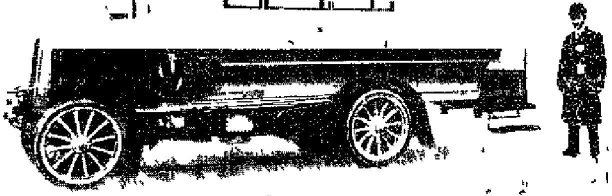

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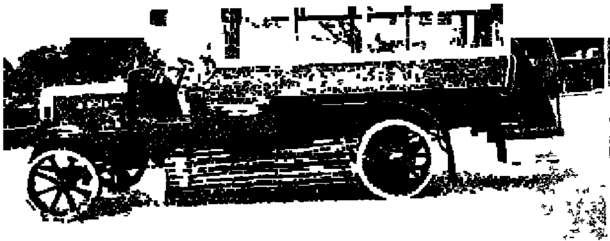
HAMMERSMITH & PICCADILLY CIRCUS



C

D

XXIV, *A*), which began to replace the horse-buses The new vehicles weighed unladen about 3½ tons, and had sixteen inside and eighteen outside seats Fitted with four-cylinder engines of 25 h p., they had twin solid rubber tyres on the rear wheels and single solid tyres on the front wheels. By the end of 1911 the vehicles of the L.G O.C consisted mainly of the new red 'Generals,' and the company, then having been acquired by the Underground, began working many new services from the Underground stations, particularly in the suburbs. Country services were extended in 1912 with daily services to Windsor, St Albans, Watford, and elsewhere.

During the War some 1300 L.G O.C buses went overseas, and after the Armistice, no longer hindered by hostilities, the bus developed rapidly. The 'K' type (Plate XXIV, *B*) was greatly improved on the mechanical side, and carried forty-six, instead of thirty-four, passengers, extra room being obtained by placing the driver's seat alongside the engine instead of behind and above it, as in the earlier type. Further improvements were embodied in the 'NS' type, with increased seating accommodation and low centre of gravity (Plate XXIV, *C*). The early motor-omnibuses had resembled the horse-buses, standing high off the ground with unprotected upper decks The 'NS' vehicles were lower, and had a covered upper deck, with upholstered seats. Then came the 'LS,' or 'London Six' type, a six-wheeled vehicle with balloon, instead of solid, tyres, with greatly increased comfort and speed (Plate XXIV, *D*) The upper deck was roofed, and there was a total seating capacity for seventy passengers Even more recently (1929) two further types have been evolved These are the 'LT' type, a six-wheeled bus with a six-cylinder engine, and seating fifty-six people, and the 'ST' type, mounted on a four-wheeled chassis with a six-cylinder engine and seating accommodation for forty-nine passengers. The principal features of both types are an all-enclosed stairway and a large platform, which facilitates loading and unloading.

The whole of the passenger traffic of London, whether by road or by rail, is now controlled by the London Passenger Transport Board In June 1934, the Board owned 5440 omnibuses covering a mileage of 2355, and in 1933 it carried two thousand million passengers in its vehicles.

While motor-buses are by far the most numerous in London, they run in many other cities in competition with the trams. They are also used for travel over wider areas in practically all districts, and it is now possible to travel in them comfortably, speedily, and cheaply, to almost any part of the country. The enterprising Great Western Railway started a motor-bus service to the summit of Plynlimmon.

Motor-coaches, as distinct from motor-buses, make possible comfortable travel both for touring and for long-distance journeys. These coaches, which superseded the motor chara-bancs of the post-War years, are well designed and powerfully engined. They are both reliable and speedy, and sometimes are able to make even better time than a railway-train. During the summer special Pullman coaches run on regular long-distance routes, as from Edinburgh to Newcastle-on-Tyne, York, Grantham, and London; London to Birmingham and Blackpool, Liverpool to Manchester, Leeds, and Newcastle-on-Tyne Motor-coach 'sleepers,' inaugurated in 1928 between London and the North, are another example of the enterprise and energy with which the road interests wage war on the railways

The extent of the facilities offered by road travel by motor-bus and motor-coach are such that in recent years the railways have suffered severely from the competition It is even predicted in some quarters that the fate of the railways will be settled in the next ten years—either they will be restored to prosperity or they will fall into a hopeless decline. Admittedly they are at a disadvantage, and they naturally and rightly demand equal road powers with their rivals, for the deprivation of which right there was no just reason The

railway companies are heavy ratepayers with vast overhead expenses, and as such they have had to shoulder burdens incomparably greater than any that the road interests have been called upon to bear. Then there have been other disadvantages—the petrol engine developed amazingly in efficiency, the price of spirit fell, and the highways were improved. All these circumstances helped to carry road transport forward while the railways remained impotent spectators. Road, in fact, had an advantage over rail of which it has made the fullest possible use. Motor-coach travel has gained in popularity because it is cheap and comfortable and because everybody gets a seat. Of late the railways have adopted a progressive policy in offering reduced fares, greater facilities, and improved conditions for travel. They have also taken over motor-coach services, and a larger measure of co-operation between the rival modes of transport has had beneficial results all round, which are reflected in the increased takings of the railway companies.

CHAPTER XIII

INLAND WATER TRANSPORT

THE use of logs or rafts for transport by water must be nearly as ancient as the use of the sledge on land. Until comparatively recent times, when artificial waterways were created to facilitate communication, inland water transport was confined to such natural waterways as lakes and rivers. Even so, the construction of canals is by no means as modern a branch of engineering as might be supposed, for many notable achievements in this connexion were carried out by the ancients. There are two kinds of canals—those constructed for the transport of passengers or goods, and those used for drainage or irrigation. With these latter we are not concerned in this book, except to say that the earliest canals of which we have any record, though designed for irrigation, were soon used for inland navigation as well. Navigable canals are divided into two kinds: boat or barge canals, and ship canals.

From the writings of Herodotus, Aristotle, Pliny, and other ancient historians, we know that canals existed in Egypt before the time of Christ.

Inland water transport existed in China from the same early period, and there were ingeniously planned canal schemes in that country over 2000 years ago. It has been said that there is scarcely a town or village in the Chinese Empire that has not the advantage either of an arm of the sea or canal. The Imperial Canal, begun in the seventh century, is over 1000 miles in length, and, according to Marco Polo, was completed in 1289. It connects Peking to Canton, and goods and merchandise have been transported along it for centuries, and it is still one of the main routes of transport.

Soon after the commencement of the Christian era canals were introduced throughout Europe—in Greece, Italy, Spain, Russia, Sweden, Holland, and France. Subsequently they were developed and extended, so that centuries before anything was done to construct a system of artificial waterways in England there was a splendid system of canals in Holland, by which nearly the whole country was placed in communication with the seaboard. There was also a system of canals in France connecting the Loire with the Seine and with the Saône.

In Britain the Romans constructed at least two canals in the low-lying parts of East Anglia The Caer, or Carr Dyke,[1] which was 56 miles in length and 50 feet in breadth, originally constructed to drain the water from the hills and to prevent the flooding of the fens, served later for the transport of corn to the army in the North of England. It extended from the Nene near Peterborough to Washingborough, on the river Witham, three miles east of the city of Lincoln, and was begun by Agricola and completed by Severus The canal was repaired and extended by Carausius, who continued it on to the borders of the Fens as far as Cambridge, and instituted a great fair, which was held when the fleet of boats set out. Under the name of Sturbridge Fair this was held until as recently as the middle of the eighteenth century, with many of the ancient Roman customs. It is now difficult to trace the course of the Carr Dyke from Washingborough to Martin, but it is visible at Walcot, Billinghay, North Kyme, Heckington, Horbling, and Billingborough, whence it travels alongside the Great Northern Railway (now part of the L.N.E.R.) to Bourne and Peterborough.

The other canal constructed by the Romans, the Foss Dyke, is still navigable to-day It is nine miles in length, and extends

[1] The word *carr* means 'fen,' and is found in place-names in many parts of Lincolnshire and generally throughout the area occupied by the Norsemen and Vikings. Examples are Black Carr, near Doncaster, and Batley Carr in the West Riding

from the west of the Brayford Pool at Lincoln to the Trent at Torksey

In view of the bad state of the roads in the earlier period of English history it is strange that it was not until the middle of the eighteenth century that any serious attempt was made to use the rivers for inland transport One reason for this, of course, was the fact that even at the best of times the amount of freight was comparatively small. As we have already seen, transport was at first dealt with by strings of pack-horses and later by heavy wagons drawn by horses or oxen. This form of transport was confined to goods of a light character such as cutlery and similar ware from Birmingham and Sheffield, cloths from the villages of Wiltshire and Somerset, and cotton and baizes from Manchester. Food and fuel were more difficult to transport (much food came from Holland and the Continent, and coal was sent by sea from Newcastle to London), being distributed from London by pack-horse or wagon. Though England had splendid natural harbours and fine tidal rivers, which were capable of accommodating the largest ships, it was impossible for commerce to develop until there were greater facilities for inland transport.

The earliest efforts to improve matters consisted of schemes to deepen or widen various rivers, in order to make navigation practicable

In a curious old book, *England's Improvement by Sea and Land*, published in 1677, Andrew Yarranton points out how much the French and the Dutch had accomplished by means of inland navigation, and what England could do to excel them in ways other than that of fighting them! Yarranton, who had travelled both in France and Holland, recommends the improvement of certain rivers so as to render them navigable, pointing out that the inland country would thus become more readily accessible for commerce. On this subject he writes: "In England there are large rivers well situate for trade; great woods, good wool and large beasts, with plenty of ironstone

and pit-coals, with land fit to bear flax and with mines of tine and lead, and besides all these things in it, England has a good air." Yarranton suggested first improving the Thames at Oxford and connecting it to the Avon and Severn, so that merchandise might be carried from a wide district around Bristol to London at half the current rates. He continues:

> If I were a doctor and could read a Lecture on the Circulation of the Blood, I should awaken all the City. For London is as the heart is in the body, and the great rivers are its veins; let them be stopt, there will be great danger either of death, or else such veins will apply themselves to feed some other part of the Body, which it was not properly intended for.

It was generally want of money that prevented any of these early schemes being put into practice—England had but little capital and even less spirit, and at this time the lower classes lived in poverty and privation—and so the early efforts for the improvement of river navigation were chiefly confined to the deepening of the beds of the rivers, the strengthening of the banks, and the clearing of the towing paths.

The disadvantages of using a natural watercourse for navigation are many The current gradually changes the form of the channel or forms sand-banks in various places, which interrupt or impede navigation when the floods subside. Frequently in summer there may be insufficient water to allow of navigation. On the other hand, in winter the current may be so strong that it not only renders navigation impossible, but may also destroy artificial constructions In many cases these and similar difficulties caused the abandonment of the extended use of river channels for navigation, and led to the construction of artificial cuts. In these cuts, which often were made parallel to the original natural river channel, the water could be kept at a uniform level by means of locks. One of the earliest canals of this kind—eleven miles in length —was the result of the passing (in 1755) of an Act for making

navigable Sankey Brook from the Mersey to St Helens. This undertaking, which was due to the "commercial and enterprising inhabitants of Liverpool," was later abandoned in favour of a new canal with locks.

An Act of Parliament passed in 1720 allowed steps to be taken to make navigable the rivers Mersey and Irwell from Liverpool to Manchester. At this time Liverpool was increasing in importance as a port, and it became very necessary to open up means of easier transport to the interior of the country As the Mersey is a tidal river, vessels were able to reach as far as Warrington, but here the river became shallow, and they could not get any nearer to Manchester. Improvements were effected by using weirs and locks, and a considerable increase in transport facilities was effected in this way. Subsequently further improvements were made by clearing out and improving the channels of three existing waterways—the Weaver, the Douglas, and the Sankey

Although not the first canal in point of time, the first canal of importance in this country was that constructed by James Brindley for Francis Egerton, third and last Duke of Bridgewater. The Duke decided to construct this canal after inspecting the Grand Canal of Languedoc, which he saw while travelling in France This canal was constructed at the end of the seventeenth century in the reign of Louis XIV, and runs from the Bay of Biscay to the Mediterranean. It was completed in 1681, and is a gigantic work, 148 miles in length, with over a hundred locks [1] and fifty aqueducts. The Duke, who was greatly impressed by this undertaking, conceived the idea of constructing a canal so that the coal found on his Wors-

[1] One of the difficulties in cutting a canal is that it must be cut on the level, and it was not until the lock system was invented that canals could be constructed through hilly country It is not certain to whom the invention of the canal lock is due, since it is claimed by both the Italians and the Dutch. One of the first canals in this country with locks, through which barges were passed to various levels, was the Aire and Calder Navigation in Yorkshire, and it is interesting to know that this canal is still in active use and is equipped with the most modern plant

ley estate could be readily transported to Manchester. In 1759 he obtained the necessary Parliamentary powers for the construction of a canal from Worsley Mill, to run eastward to Salford and westward to Hollin Ferry and the Mersey. He consulted "the uneducated but heaven-taught Brindley," and placed before him his scheme to carry the canal, by means of a series of locks, from the level of the coal-mine to the river Irwell and up again on the other side to the proposed level. After due consideration Brindley reported against the scheme, recommending instead that the canal should be carried across the river at the same level as was maintained throughout. He convinced the Duke that this bold proposition was the better scheme in all circumstances, and Parliamentary sanction to the revised plan was obtained.[1]

Brindley's scheme was criticized on all sides, the idea of carrying a canal over a navigable river being the subject of so much ridicule that it became known as "Brindley's castle in the air." Neither the Duke nor Brindley was perturbed, however, and the work proceeded as quickly as circumstances would allow. The most interesting feature was undoubtedly the Barton aqueduct, which carried the canal over the river Irwell. This was situated about five miles west of Manchester, and consisted of three arches of stone and brick. The aqueduct was 200 yards in length and 12 yards in width, the underside of the arches being 39 feet above the river, thus allowing the largest barges to pass underneath without having to lower their masts. After the first boat had passed over the Barton Aqueduct to Manchester (on July 17, 1761) the "castle in the air" became one of the wonders of the country. "Crowds of people," says a writer of the time, "including those of the first fashion, resort daily to see the greatest artificial curiosity in the world"—that of one boat passing over the top of another. The canal, which was twenty-nine miles in length, soon proved

[1] Brindley himself took the plans to London, to which city he rode on horseback, the journey taking him five days.

its great practical value, for the price of coal from the Worsley coal-field was reduced from *7d.* to *3½d.* a hundredweight.

About this time quantities of raw materials—cotton, wool, and silk—landed at Liverpool from abroad were being sent by road to Manchester to be manufactured and returned to Liverpool for export. About 40 tons of goods a week were carried by road between the two towns, and although to-day this may seem but a small quantity, in those days it was a large amount, for the general trade of the country was very limited The charge for carriage by road was £2 per ton. This high charge was accounted for by the bad condition of the roads, which made the journey by pack-horses a matter of the greatest difficulty.[1]

By water, over the old navigation on the rivers Mersey and Irwell, the cost of transport was *12s.* a ton, but it was slow and difficult because of the resistance of the current and the winding course of the rivers. Then, again, the boats required a spring tide to pass the first lock at the Liverpool end. In summer the boats would often be aground because there was not sufficient water. These delays caused considerable losses to manufacturers and merchants, and shortly after the Bridgewater Canal was opened the Duke instructed Brindley to survey the country between Stretford and the Mersey in the hope that it might be possible to extend the canal so as to connect Manchester with Liverpool

The proposed extension met with considerable opposition from several interested parties and particularly from the landowners, but after a long fight the Bill was passed by both Houses and received the Royal Assent on March 24, 1762

[1] At the best of times road transport was very uncertain, since the roads were in such a bad state that often the wagons could not get through or broke down on the way. This affected not only the merchants of Manchester, but also those of towns farther afield The clothiers of Halifax sustained great losses owing to the breaking down of wagons due to the roads, and the clothiers of Leeds and Wakefield sometimes had to suspend their business for two months at a time because the roads were impassable.

There were many difficulties to be overcome in extending the original canal, for the line of the new cut—some twenty-four miles in length—crossed bogs and quicksands. From 400 to 600 men were occupied in the work, the cost of which—about £220,000, or 1000 guineas per mile—considerably exceeded the calculations, although the operations were carried out as economically as possible

The increasing import and export trade of Manchester, as the Lancashire cotton industry developed, gave rise to the suggestion of a canal that would enable ocean-going steamers to sail up to Manchester. In 1825 a Bill was promoted for a canal forty-five miles in length, linking Manchester with the river Dee, but the Bill did not pass Parliament. In another scheme, devised fifteen years later by the Old Quay Company, it was proposed to narrow the channel of the Mersey by building retaining walls above Runcorn, with the idea that the contracted channel would be of sufficient depth to allow of the passage of ships of from 400 to 600 tons' burden

The suggestion that finally resulted in the construction of the Manchester Ship Canal was first made by a Mr Hicks, who (in 1876) wrote a letter to the Manchester Press deploring the uselessness of the rivers His protest attracted the attention of Mr Hamilton Fulton, a London engineer, who subsequently prepared plans for a waterway, and these were laid before the Manchester Chamber of Commerce in the following year. The matter created a good deal of interest at the time, but lay dormant for a year or two, until Mr Daniel Adamson called an important meeting of mayors, business men, and others in June 1882 In the following year a Bill was brought before Parliament for a canal to enter the Mersey at Runcorn, from which point the channel was to be maintained by retaining walls for some distance down the Mersey estuary. The Bill was strongly opposed, however, and finally rejected. A third Bill was passed in 1885 (after legal negotiations that had cost the company over £172,000) for a canal planned to start at

Eastham, six miles up the river from Liverpool and thirty-five and a half miles from Manchester (Fig. 33).

The first sod was cut on November 11, 1887. The construction of the canal was a notable undertaking, and was only successfully accomplished after the overcoming of many difficulties.[1] Locks had to be constructed at Eastham, Latchford, and other points—those at Eastham (where the Ship

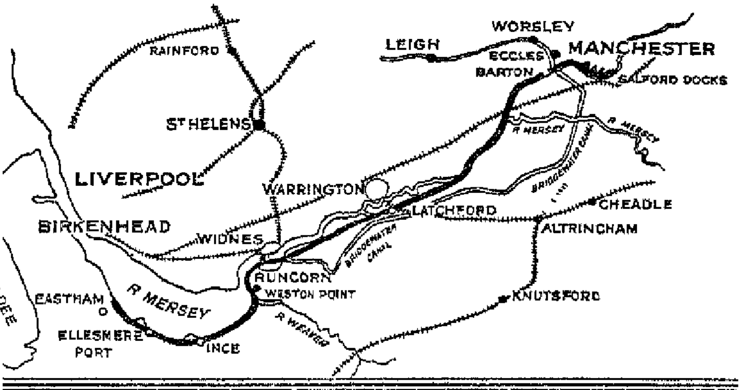
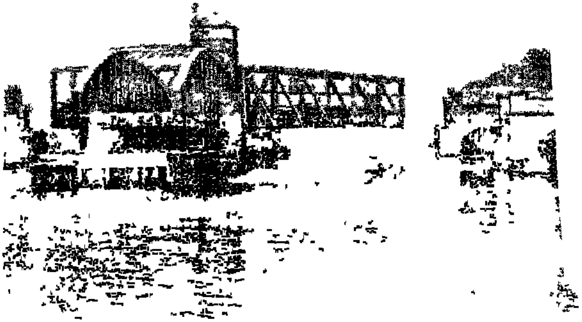


FIG 33. PLAN OF THE MANCHESTER SHIP CANAL

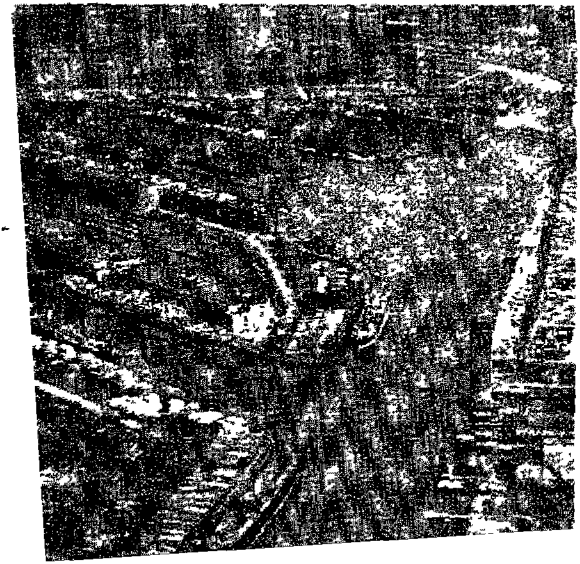
Canal joins the Mersey) consist of three terminal locks built side by side, the largest being 600 feet in length by 80 feet in width, with pairs of massive gates weighing 250 tons each. Brindley's aqueduct carrying the Bridgewater Canal over the Mersey left very little head-room for traffic using the river. It was replaced by an aqueduct that carries the upper canal over the lower waterway as before, but which can be closed at the ends (the canal ends are similarly closed, of course) and swung to one side to allow tall-masted steamers to pass (Plate XXV, *A*) The swinging portion of the aqueduct is a huge steel

[1] See Ellison Hawks, *Wonders of Engineering* (Methuen, 6*s*)

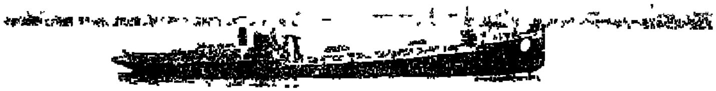
XXV



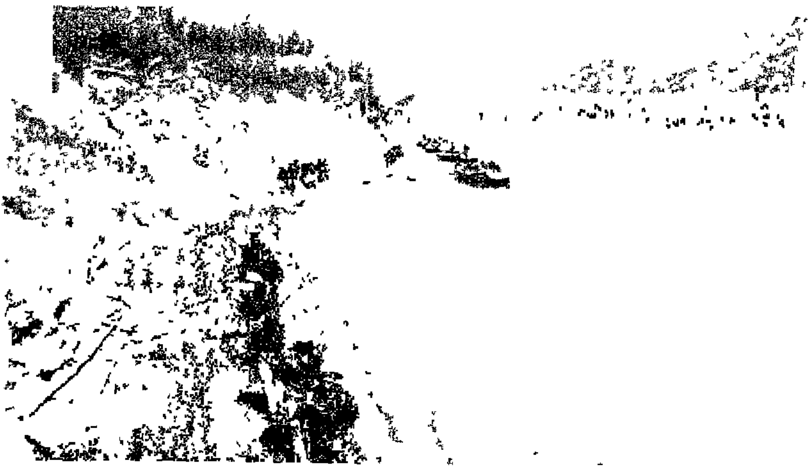
SWING AQUEDUCT THAT ENABLES THE BRIDGEWA
TO CROSS THE MANCHESTER SHIP CANAL AT BART



A. SPECIAL BARGES FOR THE TRANSPORT OF COAL
Photo: Aire and Calder Navigation



B. THE OIL-DRIVEN BARGE 'CROMFORD'
She is 77 feet in length, has a capacity of 84 tons, and a speed of 7 knots
Photo: Cement Marketing Company, Ltd.



C. TRANSPORTING FURS BY 'TRACKING' ON THE ATHABASCA RIVER
Photo by ... on ... the Govern... ... Company

trough 235 feet in length. At Manchester great warehouses and docks were erected, and the dock estate now covers an area of over 400 acres. There are eight wet docks, the last of which (opened in 1905) is 2700 feet in length and 250 feet in width. The canal, opened for traffic on New Year's Day 1894, has an annual traffic of close on 7,000,000 tons, of which the value amounts in round figures to £100,000,000, making Manchester the fourth port in the United Kingdom (Plate XXV, *B*).

The success of the Bridgewater Canal resulted in the construction of several new canals in different parts of the country and heralded a period of 'canal mania.' In his autobiography Telford mentions that about 1790, at the first general meeting of the promoters of the Ellesmere Canal (112 miles in length and connecting the Mersey, Dee, and Severn), four times the estimated cost was subscribed without hesitation. The public showed great eagerness to put money in canals, and between 1791 and 1794 this eagerness resulted in a great deal of speculation in the shares of existing companies, and the floating of many companies that were doomed to failure.

The canal era came to an end with the coming of the railway, and although some canals continued to retain a comparatively large share of the transport of the country, inland navigation as a whole became an unprofitable undertaking. The chief reason for the decline of the canal system was lack of faith in the future of the canals. Canal proprietors, who had enjoyed what was practically a monopoly of the easiest means of inland transport, seem to have been panic-stricken at the idea of competition from the railways. They strongly opposed the Bills promoted to empower the construction of the railways—exactly as the road carriers had opposed the introduction of the canals. They seemed to think that the usefulness of canals had come to an end, and, instead of developing them and keeping them up to date, their chief concern seems to have been to dispose of them as quickly as possible to the newly created

railway companies. It was in this way that the railway companies became owners of 965 miles of canals in England and Wales—canals they did not want, but which were taken over only because their acquisition was the price of the withdrawal of the opposition to the Bills promoted for the construction of railways

With one or two exceptions—those in which the waterways have been modernized—the canals of Great Britain to-day do not play an important part in transport, despite the fact that her industries have grown enormously, and as a consequence there has been a vast increase in the transport work. In their last report the Royal Commission appointed to investigate the question of water transport stated that, "with a few exceptions, waterways stand as they stood in the middle of the nineteenth century."

At the time of writing, however, it is announced that the Committee of Shipping and its associated committees are giving serious consideration to the question of modernizing the canal system in Britain Judging by various announcements made by the Ministry of Transport, it would appear that Government assistance may be forthcoming for any scheme that is approved.

It was realized in 1888 that railway ownership of canals is not beneficial, because the railway companies are organized for land transport, and their ownership of canals diminished competition. In that year Parliament prohibited, under heavy penalties, the application, without statutory authority, of railway companies' funds to the acquisition of an interest in canals

The British railway companies did not develop or improve the canals they acquired. They had, indeed, gained control over them so that they could eliminate this form of competition. Some of the canals were subsequently used for local traffic, but because of the fact that they would compete with the railways, the companies naturally have not developed them for

long-distance 'through' transport, which is a desirable and economical form of traffic.

Through transport has never been possible on the canals as it is on the railways, because of the application of the numerous tolls of the different canal companies over whose canals such traffic must pass. Before the formation of the present four railway groups the ownership of the 22,455 miles of railway in the United Kingdom was divided among some thirty-eight companies At that time there were 3321 miles of canals which were independent of railway control, and the ownership of these was shared by companies more than twice the railway companies in number. The canal companies never made any attempt to combine and organize themselves as the railway companies did, and they were without the clearing system that facilitates through traffic on the railways On the three through canal routes between London and Liverpool, for instance, there were twenty-eight different canal companies or authorities, on the four routes between London and Bristol twenty-seven; and on the three between Birmingham and Bristol ten On the shortest route between Liverpool and Hull a shipment of goods has to pass over ten different waterways, the locks of which vary in dimensions from 50 feet by 14 feet to 212 feet by 22 feet.

This variation in the dimensions of the locks on different canals is another obstacle to long-distance transport. Obviously, the size of boat that can use a canal is limited by the dimensions of the smallest lock on that canal. The want of organization in canal construction is well illustrated by the remarkable fact that the dimensions of locks vary even on the same waterway and often without any apparent reason In the Royal Commission's last report it was stated that there are 762 miles of canals with locks over 14 feet in width, and 1165 miles of canals with locks under 14 feet in width. These variations are naturally detrimental to long-distance transport, for they necessitate the use of small boats. There are many

disadvantages in the use of small boats for the transport of large volumes of traffic—the labour required to navigate a boat carrying 100 tons is not much greater than that required for one that carries, say, 30 tons; nor is the cost of haulage increased in anything like the same proportion as the increase in the load

Another disadvantage of canal transport is its slowness Certainly canals had a chance when the roads were in a bad state, but as these were improved and road traffic was speeded up the weakness of canal transport became apparent—at the time when the railway came, of course, it had an even more formidable competitor.

High speed cannot be maintained on a canal because of the serious damage that would be caused to the banks from the wash of the water produced by the passage of the boats For the same reason it is not often possible to use mechanical traction—it is, indeed, questionable whether the use of steam or electricity would be economical as applied to the small boats now in use, and for mechanical traction to be used the boats would have to be much larger. Power-driven barges have been constructed, however, and perform satisfactorily within certain limits (Plate XXVI, *B*) On the other hand, there is infinitely less friction in the case of water transport. It has been estimated that on a good road a horse will draw about 3000 pounds at the rate of about 3 feet a second, on a railway 30,000 pounds at the same speed, and on a boat in water as much as 200,000 pounds. It is to be remembered, however, that the speed of canal navigation is not solely determined by the speed of travel of the boat through the water, but is also affected by delays due to the boat passing through locks. This particularly applies in England, where the canals that pass from east to west must rise to about 650 feet above sea-level owing to the character of the country to be traversed. The boats must ascend and descend to and from these levels by flights of locks, and the negotiation of these impedes the speed of the traffic.

ıgs are used on the Aıre and Calder Navıgation, a s
serves to connect most of the ındustrıal towns of the
ng of Yorkshıre with the ports on the rivers Ouse
ıber. The Navigation owns a large fleet of mercha
es as well as many powerful tugs capable of towir
t barges at a time The Navigatıon employs wh

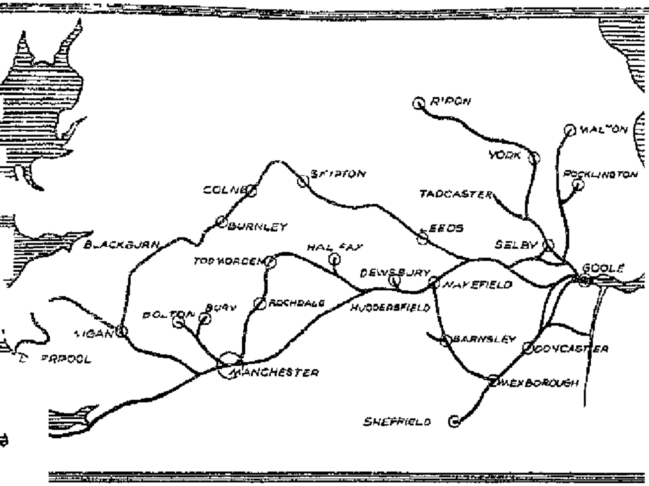


FIG 34 CANALS IN LANCASHIRE AND YORKSHIRE

ned to be the most economıcal method of inland
sport for coal; thıs is known as the Compartment
em The coal is carried in floating steel boxes ea
h holds 40 tons (Plate XXVI, *A*). These are towec
of about nineteen compartment-boats, containing
tons of coal which is thus conveyed from the wat
eries—to Goole, for shıpment—by a tug with a
our men. The locks on the lower part of the Navig
accommodate a whole train of compartment-boa
er with the tug without any disconnexion being nece
boats, loaded wıth coal, are brought on a bogie fro

colliery by means of a line of railway. They are lowered into the water, where they float off the bogie and are then taken to form the train. These unique compartment-boats, which were invented by the late Mr W. H Bartholomew, are each 20 feet in length, 15 feet in beam, and 8 feet in depth, and are constructed of iron or steel. The ends are curved to enable the boat easily to negotiate bends on the canal, and spring buffers allow the train to straighten itself after negotiating a bend. The Aire and Calder Navigation possesses no less than 1100 of these boats

During recent years considerable improvements have been made in the Grand Union Canal, which runs from the London docks through the Midlands to Birmingham. This canal, tapping as it does some of the most populous industrial areas in the country, makes a useful adjunct to our transport-system, and the steps that have been taken to renew and enlarge locks and to make the system efficient and up-to-date are securing their reward.

CHAPTER XIV

OCEAN TRANSPORT. WOODEN SHIPS

To deal adequately with the interesting story of ocean transport, as illustrated by the development of the ship, requires more space than is at our disposal in this book It has therefore been made the subject of a separate volume[1] In this chapter we give a brief outline of the story, based on the information contained in that volume

After the floating log probably the earliest navigable vessel was simply a raft of logs, lashed together and pushed along by poles This was followed by the dugout—a log hollowed out by primitive tools or with the aid of fire—which even as early as the Stone Age had reached a high state of efficiency Because it was constructed from the trunk of a single tree, the dugout was limited in length. Moreover, it was a heavy vessel and difficult to transport from one waterway to another, or from one part of a river to another, when it was necessary to avoid such natural obstacles as waterfalls or rocks. It is not surprising, therefore, that it was superseded by a much lighter boat, consisting of a framework of wood covered with bark or skins—a type that, despite the lapse of centuries, is still in use and not greatly altered from its prehistoric ancestor.

Birch-bark canoes were not suited for the transportation of goods in bulk, so at a later date strong boats were built of boards lashed together. Subsequently they were superseded by boats in which the boards were fastened together by wooden pegs.

As we have seen, the earliest form of propulsion was by poles. Paddles probably were introduced with the dugout,

[1] Ellison Hawks, *The Romance of the Merchant Ship*, Harrap (7s 6d)

and served to propel the boat in water that was too deep for poles. Paddles were used for the lighter canoes, but sails were in use also even in prehistoric times.

We do not know when ships were first employed for transport and commerce, but in very early times the Egyptians transported down the Nile on rafts the huge masses of stone which they took from the quarries to the sites of their temples Although not the first nation to employ ships systematically, the Egyptians were the first to make pictorial records of their

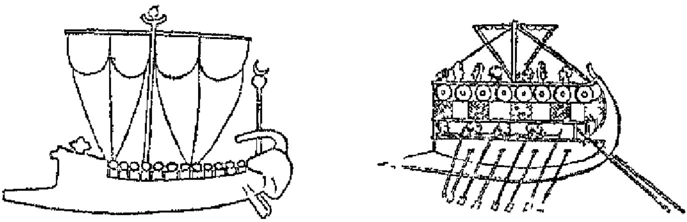


FIG 35. PHŒNICIAN SHIPS

vessels. One of the earliest pictures of a ship is found on an Egyptian vase believed to date from as early as 6000 B C This vase, which is now in the British Museum, shows a sailing-vessel with masts and square sails. Carvings in the temples and tombs of ancient Egypt show ships being used for the transport of cattle and goods on the Nile These ships had both sails and rowers, and were steered from the stern by paddles. During the period 300 to 200 B.C. the Egyptians developed a vessel with straight sides and high, overhanging bow and stern. A square sail was carried on a mast that consisted of two poles fastened together at the top and lowered when not in use In these ships oars were used instead of paddles, and the ship was steered by a single oar instead of by a number of paddles

Although they made some remarkable voyages and successfully fought various raiders at sea, the Egyptians did but little

navigation of the open sea. They never became a sea-going people as did the Phœnicians, who seem to have originally lived in Canaan and in the valley of the Jordan, whence they migrated to the sea. These people finally established themselves along a strip of coast some two hundred miles in length in what is now Northern Syria Until then the Phœnicians probably did not give much thought to the sea in connexion with the development of commerce, but when they found themselves cut off from all progress in a landward direction they determined to make use of the sea, which was their only outlet. They founded settlements along the northern coast of Africa and on some of the islands of the Mediterranean, and their ships voyaged far and wide—their fleet, indeed, is believed to have circumnavigated the African continent—bringing home mineral wealth from Spain, the Scilly Isles, and Cornwall.

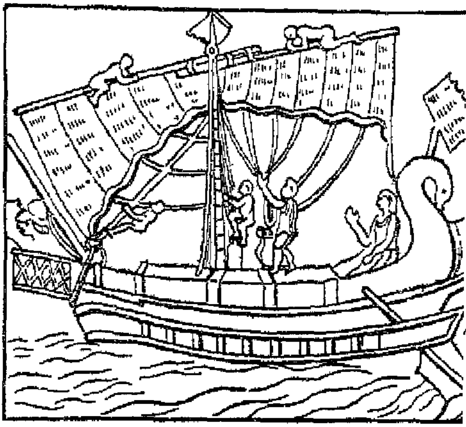


FIG 30 A ROMAN MERCHANTMAN

It is a strange fact that, despite the immense importance of the Phœnicians as a maritime nation, we know but little of their ships The earliest known pictures show galleys with high bows and sterns, manned by crews of 50 to 120 rowers.

The ships of the Greeks and Romans were employed more for war than for transport, and in these circumstances they do not call for more than a passing mention. The Greeks acquired their knowledge of shipbuilding and navigation from the Phœnicians, with whom their colonists on the islands in the

Ægean Sea and on the coasts of Asia Minor came into contact It is not surprising, therefore, that the early Greek ships were similar to the Phœnician vessels. These included biremes (that is, ships with two banks of oars), and these were followed by triremes (three banks of oars) about 120 feet in length and built for speed They were fitted also with two square sails, which could be stowed away when the ship was in action In later times the Greek trireme was replaced by larger vessels with an increasing number of banks of oars, the most popular being the quinquereme (five banks).

In many ways the early Roman ships resembled those of the Greeks, and they too were used for warlike purposes, although after the battle of Actium ships were used for the transport of corn and other freight from Egypt to Rome. We have little information about these ships, however, except that they are believed to have been at least 200 feet in length. It is interesting to remember that the ship on which St Paul journeyed to Rome carried 277 people including the crew, in addition to a considerable quantity of cargo

The Romans had no aptitude for the sea, but saw the necessity of conquering it in order to overcome their enemies, the Carthaginians By chance a Carthaginian ship, a quinquereme, fell into the hands of the Romans, who examined her, and within sixty days not only built a fleet, but sailed forth to meet the enemy on his own element Although beaten on this occasion, they continued to build ships until at last, after having suffered many losses due to inexperience, they succeeded in defeating the Carthaginians and became masters of the Western Mediterranean. After the fall of Carthage the Romans continued to build vessels of great size, but after the battle of Actium—when the large Roman ships were vanquished by smaller fighting galleys with only two banks of oars—the quinquereme was abandoned in favour of the bireme, which remained the standard for many centuries.

When the Phœnicians visited Cornwall they found that

the Britons were using small boats, the ribs of which were made of slender pieces of wood tightly covered with skins. Although these crude vessels were obviously unsuited for voyages of any length, they enabled the ancient Britons to maintain intercourse with the people of Gaul and Ireland By the time Julius Cæsar came to Britain the Britons had developed larger and superior vessels, which Cæsar describes as being exceedingly large and strong Built of thick oak panels, they were propelled by oars and by sails made of skins sewn together and hoisted by leather thongs. After the coming of the Romans many improvements in shipbuilding were introduced. Britain became a great corn-growing country, and some 800 vessels were employed in the transport of corn from London to the Roman provinces. Valuable privileges were conferred on those who built large ships for this trade

It was about this time that the first distinction between trading vessels and fighting ships was made The former were broader in the beam, while the latter carried protective structures to give cover to the fighting men. The Romans found it necessary to maintain fighting ships to protect the British merchant fleet, for the Angles and the Saxons—who subsequently succeeded in conquering Britain when the Roman support was withdrawn—sailed across the North Sea in the hope of securing plunder. By the time of Alfred the Great the inroads of these people, and those of the Norsemen and the Danes, became so serious that Alfred realized the necessity for building a fleet to meet the invaders on their own element. This was the beginning of Britain's naval power and of the supremacy that she has maintained for centuries

Alfred's successor—his son, Edward the Elder—continued to develop the navy founded by his father, and side by side with the development of warships proceeded the growth of merchantmen. At this time these vessels were used chiefly for transporting English wool to be woven into cloth in the

Low Countries, and also for the export of tin and lead, the oldest British exports. In return for these commodities the ships brought back jewels and gold, silks, wine, oil, and articles of ivory, glass, and silver

During the centuries that followed great changes were brought about both in the size of ships and in the manner of propelling them, English sailors learning many lessons from contact with the mariners of other countries. Sails were developed so that a ship could tack across the wind, or even sail fairly close to it The spritsail was introduced—this was a small square sail carried on the bowsprit, which effectively aided a ship in swinging from one side to the other. Additional masts were used so that a greater area of sail was available, and full advantage could thus be taken of every breath of wind; and by the time of the Tudors three-masted ships were common The height of the masts was increased with the same purpose in view, one section after another being added until the simple mast of the early sailing-vessels had grown into a structure of three or four spars, rising one above the other

Important changes took place in the design of the hulls, which in the earlier ships had been very clumsy, and raised structures (called respectively 'forecastles' and 'stern castles') were added at the bow and stern. Originally they were simple platforms reserved for officers or as aids in navigating and fighting, but later developments resulted in their becoming ungainly, giving the ships a most unseaworthy appearance. Ultimately their height was reduced, until by the time of Queen Elizabeth the forecastles had disappeared. The sterns, however, had become high structures of many decks and cabins, but ultimately they too were reduced in height By the time of the Commonwealth the quarter-deck was only a few feet higher than the main deck, and the bows were only of sufficient height to afford some measure of protection from the waves

The discovery of the New World by Columbus made ships

and shipping more important than ever, and great strides were made in the art of building seaworthy vessels

Let us make a brief survey of the world events that led up to notable developments that occurred later. The conditions under which the people of England lived in the fifteenth century are almost beyond our conception. Their foodstuffs varied according to the season of the year, and livestock was kept through the winter only with great difficulty. It was customary to kill a large number of animals before the winter set in, and to preserve them by salting for consumption during the winter months. The eating of this salted flesh and the absence of fresh vegetables gave rise to scurvy and similar diseases, and it became a matter of life and death that condiments and spices should be obtained. For centuries the Phœnicians had brought spices from the East, and had exchanged them for wool, cloth, and metals. The conquest of Constantinople (in 1453) resulted in the Turks' controlling the supplies between East and West, a situation that hindered trade considerably. Shortly after this, however, a new route to India was discovered, for Prince Henry the Navigator coasted down the west side of Africa. His countryman, Vasco da Gama, rounded the Cape of Good Hope, arriving at Calicut on May 20, 1498. This discovery of a new route was of great importance, for now European traders could reach the Far East and India without their passage being controlled by the Turks.

At the same time Columbus determined to find a passage to India by sailing westward, and, although his own countrymen in Italy and Henry VII of England refused him support, ultimately Ferdinand and Isabella of Spain furnished him with ships and money. On August 3, 1492, with 120 men, he set sail in three small ships, and after a memorable voyage landed at one of the islands of the West Indies. He returned in March of the following year, not knowing that he had discovered a new world, and under the impression that he had reached land near India.

In the meantime English sailors had been endeavouring to discover a north-east passage that would serve as an alternative route to India Sir Richard Chancellor, although failing to reach India, sailed into the White Sea and opened up commercial relations with Russia, as a result of which a large trade grew up between the two countries. In the other direction the Cabots had attempted to find a north-west passage, and although they failed they discovered the coast-line of North America. During the latter half of the sixteenth century and the whole of the seventeenth century new routes and new countries were studied and explored. When Spain and Portugal failed, and the Spanish Main offered booty to those who would take it, the Dutch became the leading world-traders, a supremacy that England obtained later as a result of Cromwell's policy. Subsequently the work of exploration was completed between 1768 and 1779 by the discoveries of Captain Cook, and from this time onward trade developed throughout the world, an enormous number of new routes having been opened up.

Among the greatest developments were those that took place in the reign of Queen Elizabeth, and, remarkable to relate, these arose in the first instance from a decision to combat the high price of pepper! At that time this and other spices were obtained, as they are to-day, from the East Indies The trade was almost the monopoly of the Dutch, who, taking advantage of their favourable position, in 1599 raised the price of pepper in England from 3*s* to 6*s*. or even 8*s*. a pound This caused great indignation in London, and the merchants of the city formed a company to trade direct with India. As a result, the East India Company was incorporated by Royal Charter on December 31, 1600, and during the following twelve years the company's vessels made ten voyages very successfully to the East. Its Charter gave the Company a trade monopoly with the Far East, and from headquarters in Leadenhall Street, London, the Board of Directors virtually

governed an empire In those days there was no submarine cable, and no steamships sailing between England and India, so that all communications were by the long sea-route round the Cape of Good Hope. The time thus required for the voyage necessitated a great deal of power being left in the hands of the Company's managers in the Far East

The East India Company's fleet consisted of the finest vessels of their time—all well manned and heavily armed, and capable of holding their own even against warships. The Company continued to prosper for a long period, but gradually political influence brought about a change in its character By 1831 to a large extent it had become merely an administrative agency, and its end came in 1858 when the Government of India passed to the Crown

The East Indiaman as a type held her place until the nineteenth century, and along with another type—the 'free-trader'—transported most of the ocean freight. The Indiaman was the link between England and the Far East, while the free-trader traded with other parts of the world The latter type of ship was of small tonnage compared with that of the Indiaman—her tonnage might be between 300 and 700 tons, the Indiaman's varying from 1000 to 1500 tons The free-trade ships had not the benefit of a Charter such as the Indiamen had, and were therefore open to competition from all other nations They met this competition by running economically and carrying every possible ounce of cargo—in other words, they were of necessity practical ships capable of doing a large amount of work at a small cost. These two types of ships were important, for modern English shipping has evolved from the experience gained through them.

All along English shipbuilders had adhered to the bluff bow and heavy stern, both of which militated against speed, but about the middle of the nineteenth century a new class of ship came into existence. It originated in America, where the shipbuilders decided to produce a ship that would outsail any

her ship on the seas, by doing which they hoped e pick of sea-borne trade. The 'clipper' ship, as pe was known, played an important part in the ean transport from this time to the coming of tl

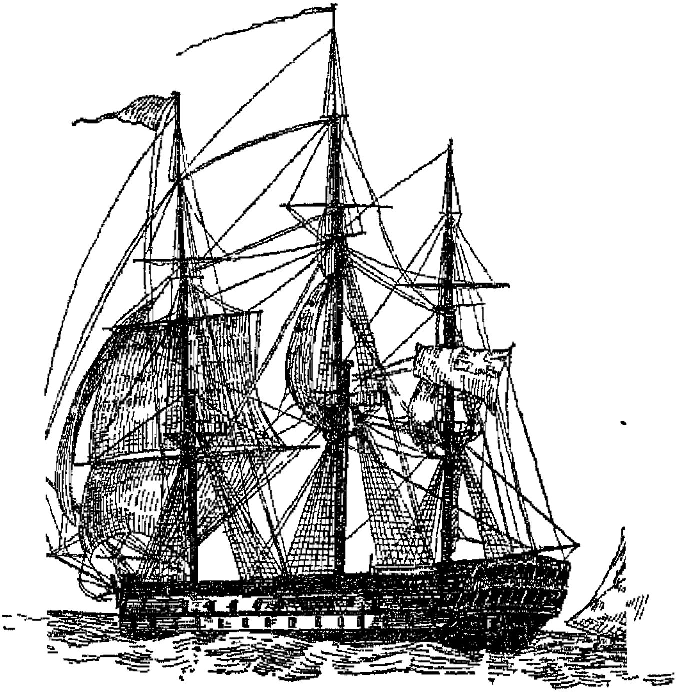


FIG 37 AN EAST INDIAMAN

.e ships were first employed in the China tea trade the Australasian and West Coast trade, and man :iting stories told of the races between these ship XVII, *A*) Their chief improvements were in the : hull—the greatest breadth was nearer the stern—a w, which was finer and sharper. This enabled t 'clip,' or cleave a passage through the sea, instead

ing the water on one side, as was the case with the earlier ships. The first of the clippers was the *Rainbow*, launched in 1845. She had a successful but short career, for she was lost on her fifth voyage She was soon followed by others of the same type, and for some years the American clippers ruled the seas.

British shipbuilders were not slow to take up the challenge offered by the Americans, and they built ships that not only equalled the American vessels, but actually outsailed them. Then ensued the great rivalry for the China tea trade, a struggle that was ultimately won by the British clippers, whose rivals were finally put out of the running by the American Civil War.

When the British navigation laws were altered (in 1849) to allow foreign ships to compete for ocean transport between Britain and her colonies, the American shipowners attempted to capture the trade from the East to Europe The year 1853 saw the launching of the *Great Republic*, one of the largest sailing-ships ever built. She carried an enormous sail area—her main mast was 131 feet in height, and on it rose the topmast, the topgallant mast, the royal mast, and the skysail mast —the total height of all was over 288 feet. The vessel never made a voyage with this rig, however, for when loading in New York Harbour her rigging was accidentally set on fire, and when refitted she had smaller masts. Even then she made a crossing from Sandy Hook to Land's End in thirteen days.

Perhaps of all the famous clippers of the nineteenth century the two that won the greatest renown were the *Thermopylæ* and the *Cutty Sark*. The former, built in 1868, is regarded as the fastest all-round sailing-ship ever constructed. Her regular runs were from Newcastle, Australia, with a cargo of coal to China, thence to England with a cargo of tea. She broke several records, and on one occasion sailed from the Lizard to Melbourne in sixty-two days. The *Cutty Sark* was built in 1869 with the express intention of outsailing the *Thermopylæ*.

She was a wonderful vessel, and although she co haider, particularly in heavy weather, than any famous tea-clippers, she never succeeded in m wonderful series of passages as the *Thermopy* chiefly employed in transporting cargoes of Australia, and on occasions her voyages occupied eight days

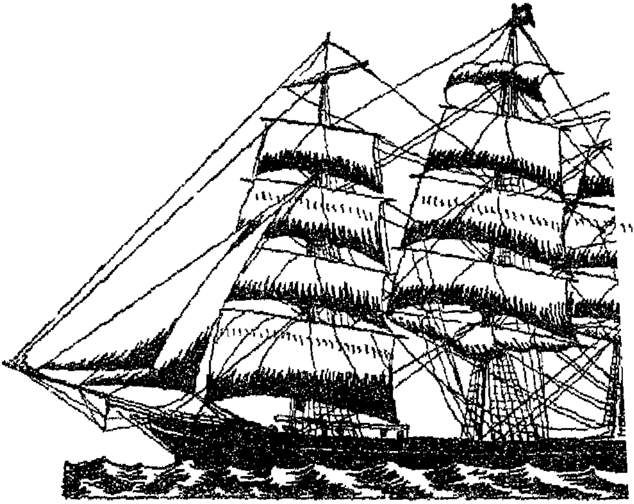


FIG. 38 THE "THERMOPYLÆ"

The days of the clipper were numbered almos began, and before long the wonderful sailin driven from the seas by the more efficient ste first there was some opposition to the use of ste transport of such delicate commodities as tea and supposed that the carrying of them in anythin ships would spoil their flavour. In 1863, howev the *Robert Lowe*, brought a cargo of tea from Hank and it was found that the tea had suffered no in this example was followed by other steamships

were doomed, and these fine ships were taken off the run and used on other routes, particularly those to Australasia and the west coast of South America The result of this revolution in ocean transport has been that, whereas a century ago the sailing-ship could carry only in small quantities commodities that were regarded as being the luxury and privilege of the wealthy, to-day economical transport facilities have resulted in most of these one-time luxuries being available even to the poorest in the form of food or clothing

Another factor that sealed the fate of the clipper ships was the Suez Canal, which enabled steamships to take a short cut to the East The canal had long been projected when, in 1849, Ferdinand de Lesseps began to formulate the plan that ultimately was carried to success. It was not until 1858, however, that he formed a company to construct the canal, and early in the following year a start was made on the work. The canal was completed only after numerous difficulties, both political and engineering, ha

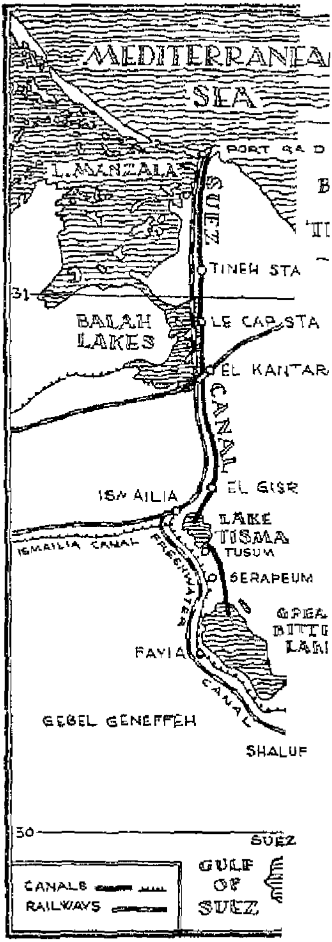


FIG 39 PLAN OF THE SUEZ C

overcome, and cost over £16,000,000—more than double the original estimate of de Lesseps Opened on November 17, 1869, it quickly became a great success, providing as it did a short cut of 132 miles from the Mediterranean to the Red Sea, thereby reducing the voyage between Europe and India by about 3700 miles

The first attempt to use steam for the propulsion of a vessel is said to have been made in 1543 by a Spaniard named Blasco de Garay. The experiment is stated to have been carried out in Barcelona Harbour, but the details are vague, and the whole story seems doubtful In 1690, Denis Papin suggested that his engine might be used for the propulsion of ships by means of paddle-wheels, but it was not until 1707 that one of his engines was tried in a small boat. The trial, which was made on the river Fulda in Germany, resulted in disaster; for the local boatmen, fearing they would be deprived of their livelihood if the experiment was a success, attacked the boat by night and completely destroyed it In 1736 an Englishman, Jonathan Hulls, patented a steam-propelled vessel, using an engine of the Newcomen type, but his experiments were not a success

Of the many other inventors in Europe and in America the most notable was Robert Fulton, born in Pennsylvania in 1765 Fulton, who was the first man to bring steam navigation to a commercial success, went to Paris in 1797. Six years later, with the financial assistance of Robert Livingston—then United States Ambassador in Paris—he completed a steam-boat which he proposed to test on the river Seine. Unfortunately, the hull of the boat would not carry the weight of the machinery, and the night before the trial it broke in two and sank. Fulton recovered the machinery and built a stronger hull, 66 feet in length and 8 feet in beam In the following August the boat was tried on the Seine, steaming up the river at a speed of 4½ miles an hour. In 1806 Fulton returned to the United States, after having ordered from Boulton and Watt an engine built to his own design This engine was

duly delivered and built into a hull, the vessel being named the *Clermont*. She was launched in 1807, and was 133 feet in length and 18 feet in beam. Her trial trip from New York to Albany (150 miles) was accomplished in thirty-two hours, and the return trip in two hours less This was the first voyage of any length ever made by a vessel under steam alone The success of the *Clermont* was so complete that Fulton advertised that he would run a regular passenger service between New York and Albany.

In Britain the pioneers of steam navigation were Patrick Miller and James Taylor. In 1786 the former constructed a vessel with rotary paddles driven by a crank turned by four men. After this vessel had won a race against a sailing-wherry Taylor suggested the application of steam to drive the paddles. Accordingly in 1788 an engine was built into the boat, which was tried out on the lake at Dalswinton (Fig. 40) In the following year another vessel, 60 feet in length and fitted with a steam-engine, attained a speed of about seven miles an hour on the Forth and Clyde Canal William Symington, who had built the engines for Miller and Taylor, built the *Charlotte Dundas* in 1801. She was 56 feet in length and 18 feet in beam, and was fitted with horizontal, direct-acting engines driving a paddle-wheel at the stern. Even against strong winds she was able to tow two 70-ton barges for nearly 20 miles in six hours In 1812 Henry Bell, of Helensburgh, built the *Comet*, 40 feet in length and 10½ feet in beam, with which he carried passengers between Glasgow and Greenock on the river Clyde. The first British steamboat to make a sea voyage was probably the *Elizabeth*, built in Glasgow in 1813 and taken to Liverpool two years later

From this time onward steamship-building proceeded with great rapidity, better ships being built year by year as experience was gained. In 1816 regular steamship communication was established between Great Britain and Ireland, and in the same year the *Majestic* was the first steamship to be employed in towing ships on the Thames. As it had been

with canals, and as it was to be with railways, with steamships Companies were formed in co numbers, with the result that before long there was arising out of too keen competition. The cuttin

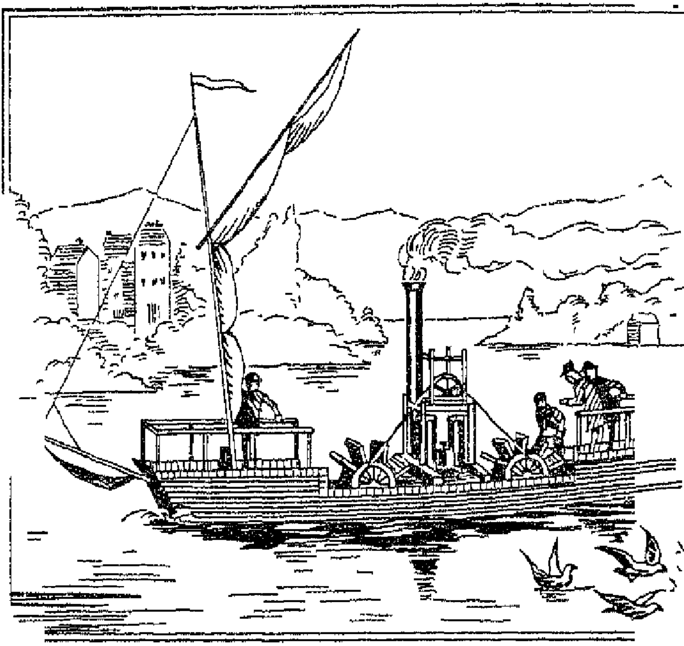


FIG 40 THE TRIAL OF MILLER'S STEAMBOAT

was carried so far that at one time the steerag tween Liverpool and Belfast, including bread and only 3*d* !

Up to about the middle of the nineteenth centur of engine used was the side-lever engine, and this typ standard until the paddle-wheel was superseded by propeller The side-lever engine was used on ma finest vessels until 1860, including the first four ve

Cunard Line in 1840. It was well adapted for its purpose—it had practically no dead point and therefore was able to start from almost any position, and it was so reliable that it would continue to work satisfactorily even when thoroughly neglected. It had certain disadvantages, however, the chief of which were the large amount of space it required and its great weight. It was too slow for screw propulsion, and when paddle-wheels were superseded by propellers a new engine had to be evolved. Several types were introduced—both horizontal and vertical—but subsequently the inverted vertical engine became the most popular, and this type was only superseded by the steam turbine.

The success of steamships in both Europe and America naturally suggested the possibility of crossing the Atlantic under steam, but which ship was the first to make the trip is a matter of some uncertainty. The honour has been claimed for the American ship *Savannah*, but she was a sailing-vessel fitted with an auxiliary steam-engine. She made her first crossing on May 24, 1819, using her sails nearly the whole of the voyage except when entering or leaving port. She was 130 feet in length and 26 feet in beam, and her first trip, which was without passengers or cargo, required 29 days 11 hours. The *Rising Sun* seems to have been the first steamship to cross the Atlantic from east to west. She left Gravesend on October 22, 1821, and arrived at Valparaiso in April the following year. She also was a sailing-ship with auxiliary engines, but it is not known to what extent her engines were used on this voyage.

The *Sirius*, 178 feet in length and 25½ feet in beam, left London on March 28, 1838, and reached New York on April 22, the voyage thus occupying sixteen and a half days. She was fitted with side-lever engines and carried a number of passengers, variously stated to have been from forty to ninety-four, but no cargo. Within a few hours of her reaching port a second steamship, the *Great Western*, steamed into New York, having left Bristol on April 8. Built by Brunel, she

was 263 feet in length and 59 feet 8 inches in breadth including paddle-box Her tonnage was 1321, and her engines were of 450 h p. On her return voyage she carried sixty-eight passengers and made the trip in 14 days, after which she ran regularly between Bristol and New York until 1846.

The success of the *Great Western* caused the British Government to invite tenders in 1838 for the conveyance of the American mails by steamship. This offer came to the notice of Samuel Cunard, who came to England from Nova Scotia, and obtained the contract for seven years for the conveyance of the mails fortnightly It was in this way that (in 1840) the Cunard Steamship Company originated, and its establishment marked the commencement of a new era in Atlantic steamship service

CHAPTER XV

OCEAN TRANSPORT IRON AND STEEL SHIPS

THE suggestion that ships should be built of iron was made as early as 1809 by Trevithick, the builder of the first locomotive successfully to run on rails. The suggestion was received with ridicule, because at that time the public could not conceive that an iron ship could possibly float Wooden ships were subsequently built larger and larger, until at last it came to be realized that there was a limit As the size of the ship was increased, so the strength and thickness of the timber had to be increased in proportion Even with the strongest construction, however, wooden hulls were liable to droop amidships or at their ends. Thus the attention of shipbuilders was turned to the possibility of using iron It was found that iron frames could be sheathed with iron plates and that vessels could be built which would not only float, but which had a considerably greater carrying capacity and immensely greater strength than wooden craft of the same dimensions

The first attempts at iron construction were in the form of barges for inland waterways Then followed the first iron steamship, the *Aaron Manby* (built in 1821), a small vessel, 106 feet in length, 17 feet in beam, and fitted with a 30-h p engine Various other small vessels were built during the next few years, but they did not attract particular attention In 1834 the *Garry Owen*, 125 feet in length and 21 feet 6 inches in beam, encountered very severe weather on her first voyage Along with several wooden ships she was driven ashore, and although the former were either smashed to pieces or badly damaged, the *Garry Owen* was refloated none the worse for her experience. This incident formed a striking object-lesson in

the superior strength of the iron ship, and it had a considerable influence on the future of iron construction

It was not long before it became evident that the iron ship was superior for all ocean-going purposes, and in the building of these ships British shipbuilders had a great advantage. Not only was Great Britain the chief iron-producing country of the world, but the men of the shipyards were skilled in iron construction work Gradually iron gave way to steel, the greater strength of which enabled the weight of the hull to be reduced and effected even greater economies than those resulting from the earlier replacement of wood by iron. The inventions of Bessemer and Siemens flooded the world with cheap steel, which after 1874 completely replaced iron in marine construction.

About this time there was in progress another far-reaching change—the introduction of the screw-propeller. The first screw-propelled boats were American, and were in operation on the Hudson River from 1802 to 1806. Remarkable to state, the British Admiralty was prejudiced against propellers, and, in spite of practical demonstrations, maintained that a vessel in which the power was applied at the stern could not be steered! The first sea-going vessel driven by a propeller was the *Archimedes*, 125 feet in length and 22½ feet in beam, which made a voyage round Great Britain. By a lucky chance she called at Bristol, where a successor to the *Great Western*—the *Great Britain*—was being built. The superiority of the screw-propeller made such a favourable impression on the builders of the *Great Britain* that, although the latter had been designed for paddle-wheels, the necessary changes were made to substitute the screw-propeller. The *Great Britain*—the first large ocean-going steamer with screw-propulsion—was 322 feet in length, her beam 51 feet, and her tonnage 3500 She sailed from Bristol for London in January 1845, and completed the voyage at a speed of just over 12 knots. Later she went to Liverpool, leaving the Mersey on July 26, 1845, on her first transatlantic voyage. She carried about sixty passengers and

600 tons of cargo, and made the voyage in 14 days 21 hours at an average speed of $9\frac{1}{2}$ knots

One of the first to realize the possibilities of the iron ship fitted with a screw-propeller was William Inman, of Liverpool, the founder of the Inman Line. His idea was to run first-class steamers between Liverpool and America, and to cater particularly for the transport of emigrants, who up to that time had been carried in unsuitable sailing-ships with inadequate accommodation. The Inman Line commenced transatlantic traffic with the *City of Glasgow* (acquired in 1850), and the *City of Manchester* (purchased the following year), both of which were 227 feet in length and 33 feet in beam. Each vessel had accommodation for fifty-two first-class passengers, eighty-five second-class passengers, and four hundred steerage, and a crew of seventy. Inman's project was a great success, and more ships were added, until the Inman Line became a severe competitor of the Cunard.

Competition was further intensified by the advent of the White Star Line, which originated in a fleet of large and fast clipper ships, the management of which T H Ismay took over in 1867 Later a passenger service between Liverpool and New York was commenced, and the Oceanic Steam Navigation Company was formed The first vessel of the White Star fleet was the *Oceanic* (launched in 1870), 420 feet in length, 41 feet in breadth, and tonnage 3707. She was the pioneer of the modern type of fast ocean liner, and was followed in quick succession by six other ships. The last two of these were the *Britannic* and the *Germanic*, each 455 feet in length and 45 feet in breadth, with a gross tonnage of 5000 These vessels had a speed of over 16 knots, and reduced the transatlantic crossing to less than seven days.

Mention must be made of the *Great Eastern*, one of the most famous ships of modern times. This vessel was built for the Eastern Navigation Company (formed in 1851), and was 693 feet in length and 83 feet in breadth, with a gross

tonnage of 18,915 She was built of iron and had two paddle-wheels and a screw-propeller. Her speed under paddle averaged 7 knots, under screw 9 knots, and with both paddles and screw 15 knots. She was designed as a passenger-and-freight liner, with accommodation for 800 first-class, 2000 second-class, and 800 third-class passengers, and was launched on January 31, 1858 In anticipation that the Government would commission her as a transport the accommodation was so arranged that 10,000 troops could be carried. The only occasion on which she was used for the transport of troops, however, was in June 1861, when she conveyed 2125 soldiers and 200 artillery horses to Canada. For her first long-distance voyage she left Southampton on June 17, 1860, and arrived at New York on the 28th of the same month, the return voyage being accomplished in 9 days 11 hours. During the three years 1860–63 she made nine transatlantic voyages, but financially she was a failure because she was before her time In 1864 she was hired to lay the Atlantic cable, and after many disappointments and failures (which, however, were not due to the ship) the cable was successfully landed at Trinidad Bay, Newfoundland, on July 28, 1866. The *Great Eastern* continued to be employed on cable-laying work until 1886, and five years later was broken up in a Merseyside shipyard.

Much might be written about ocean transport in the succeeding years, but we must confine the remainder of our remarks to some of the modern liners

So far as the transatlantic service is concerned, two of the most famous Atlantic liners of recent years were the Cunarders *Lusitania* and *Mauretania*—length 788 feet, beam 88 feet, and tonnage 31,000. These vessels were designed to steam at 24 or 25 knots, and represented an enormous advance on any of their predecessors, winning from Germany the blue riband of the Atlantic held by that country from 1898 to 1907 The *Lusitania* sailed on her maiden voyage—from Liverpool to New York—on September 7, 1907, her departure being

witnessed by over 200,000 people. On this voyage she averaged 23 knots despite fog, and on her second voyage improved her speed to 24 knots. Subsequently she made ten consecutive voyages at an average speed of 25 knots and over, and could maintain this average without difficulty In one year the *Lusitania* crossed no fewer than thirty-three times, covering 100,000 miles and transporting 41,000 passengers She was sunk in 1915 by a German submarine off the coast of Ireland, an act that helped to bring the United States into the War

Whereas the *Lusitania* was built on the Clyde, the *Mauretania*—which was scrapped in 1935—was built on the Tyne In 1907 the *Mauretania* underwent extensive alterations—among other changes was the fitting of two new propellers, the cleaning of 192 furnaces, and the thorough overhauling of the six turbines. At the same time she was converted from coal- to oil-burning and given a storage capacity for oil of over 7000 tons After this overhaul she was subjected to a speed test in the English Channel, and for two hours kept a speed of 26 knots. For twenty-two years she held the Atlantic record, but in 1929 this was taken by the German liner *Bremen* (938 feet in length, 101 feet in breadth, and a tonnage of 51,656) (Plate XXVII, *B*). The *Bremen* has accommodation for 800 first-, 500 second-, 300 'tourist third-,' and 600 third-class passengers. Her crew of 960 brings the full complement of the ship to 3160 persons. She was specially designed and built for speed, and on her first attempt succeeded in making a new record for the Atlantic crossing between Cherbourg and New York, which she accomplished in 4 days, 17 hours, 42 minutes, beating the *Mauretania's* fastest time by 8 hours 52 minutes. On her return voyage the *Bremen* maintained the remarkably high average speed of 27·9 knots, making the voyage of 2084 miles between the Ambrose Lightship and the Eddystone in 4 days, 14 hours, and 30 minutes. Immediately after this performance the *Mauretania* put up a

new record when leaving Cherbourg On August 3, 1929, she arrived at New York only 4 hours 2 minutes behind the time of the *Bremen*, in spite of head winds and heavy seas. On her return voyage the veteran Cunarder did even better, averaging 27 2 knots and completing the journey in only 3 hours 19 minutes more than the time occupied by the *Bremen* on her first return trip

Since that time the Atlantic record has been further lowered by the *Europa*, a sister-ship of the *Bremen* and of similar dimensions This vessel was launched in August 1928, but her completion was delayed by a disastrous fire which broke out on board while she was being fitted out. On March 25, 1930, while on her maiden voyage, she made the crossing between Cherbourg and the Ambrose Channel Lightship in 4 days, 17 hours, 6 minutes, at an average speed of 27·91 knots. This time is eighteen minutes less than that of the *Bremen's* fastest run

In September 1934, the giant Cunarder *Queen Mary* was launched from the yard of Messrs John Brown and Co , Clydebank. The building of this vessel had been delayed owing to the industrial depression, and the announcement that work upon her was being resumed gave a welcome fillip to British shipbuilding The new vessel will be designed for a minimum speed of 28 knots, and her actual speed will be well over 30 knots. Her tonnage will be 73,000, and her over-all length 1000 feet or more. It is of particular interest to learn that the new ship will be driven by single-reduction geared turbines, taking steam from boilers of a new pattern, details of which are not yet available The total power output will probably be from 190,000 to 200,000 s h.p.—that is, from 60,000 to 70,000 h.p. more than the designed output of the *Bremen*

To return to the Cunard-White Star fleet, the *Mauretania* was followed by the *Aquitania* (length 901 feet, beam 97 feet, and gross tonnage 45,647). She was fitted out on a particularly magnificent scale, and has accommodation for passengers and

crew amounting to 4202. The feeding of this army of people at sea, where every article of food has to be provided in advance and stored for days, is a great undertaking, but perfect organization based on long experience makes it possible without confusion. After the *Queen Mary* the largest Cunarder to-day is the *Berengaria*, formerly the German *Imperator*, which was handed over to Britain by her builders as part reparation for shipping sunk by German submarines Her length is 911 feet, beam 98 feet, and gross tonnage 52,226.

In passing it must be mentioned that the vessels of the Cunard Company rendered magnificent service during the War, transporting nearly 1,000,000 troops and 10,000,000 tons of cargo, and steaming a distance of nearly 2,500,000 miles.

At the time of writing the largest ship in the world is the French liner *Normandie*, which has a gross tonnage of 75,000 tons. The *Queen Mary* follows, and the third place is taken by the *Majestic* (60,000 tons) which is fitted with 100,000-h p turbines, and on her trials developed 24½ knots.

The average consumption of fuel oil during her passage across the Atlantic is about 5700 tons She has nine decks, and carries 900 first-class, 680 second-class, and 1000 third-class passengers, with a crew of 1100, making a total of 3680

Another monster liner is the *Leviathan*, an American-owned ship with an over-all length of 950 feet, width 100 feet, and gross tonnage 59,956. Originally the German *Vaterland*, she was at New York when war broke out and remained there until 1917, when the United States joined the Allies. The ship was seized and converted for use as a transport, in which capacity she made ten trips across the Atlantic carrying 119,511 United States troops. After the Armistice she was reconditioned and placed on the American Atlantic passenger service. She accommodates 976 first-class, 548 second-class, and 2117 third-class passengers, with a crew of 1150, making a total of 4791 persons. She too has been converted from coal- to oil-burning, and has a storage capacity of 9500 tons of oil fuel.

In addition to the Atlantic trade there is, of course, a great ocean-transport business done with other countries. Trade with the East is largely carried on by the Peninsular and Oriental Steam Navigation Company, or the P. and O., as the line is more familiarly known. The company has a fine fleet of liners, the latest of which—the *Viceroy of India*—is the first British-built large passenger liner to be equipped with electric propulsion. She is a combined passenger-and-freight vessel, with accommodation for 415 first-class and 258 second-class passengers. In 1929 on her trials this ship put up an average speed of 17 1 knots in adverse weather conditions.

The Elder Dempster Line, which trades mostly with the West Coast of Africa, has had a rapid development. In 1900 its fleet had an aggregate gross tonnage of 151,593, which by 1925 had reached approximately 1,350,000 tons

The Royal Mail Steam Packet Company began its career with wooden paddle-steamers, and has run ships to almost every port in the West Indies The line has countless ramifications, however, and runs vessels to almost all parts of the world, both east and west.

The Union-Castle Line resulted from fusion in 1900 of the Union Steamship Company, Ltd , and the Castle Line. The former company began operations in 1853 with a fleet of coal-carrying vessels which were used by the British Government during the Crimean War Later the company obtained contracts for the transport of the mails and developed a mail line. The Castle Line was formed in 1862, and consisted of sailing-ships which ran between Liverpool and Calcutta The latest vessel of the Union-Castle Line is the *Carnarvon Castle*, a famous motor-ship.

The Canadian Pacific Railway is one of the best-known large railway organizations that also maintain an extensive fleet of ocean-going vessels. It commenced its Pacific passenger service in 1887 with three of the older smaller ships of the Cunard Line, which were purchased from that company. The

experimental service was a great success, and in 1890 the Government paid the company a substantial sum for the transport of mails on condition that modern twin-screw steamers were used. Three new ships were therefore built and placed in service, and the old Cunarders were withdrawn. With the new ships, which were all of 6000 tons, the Canadian Pacific Railway established a regular mail service between Vancouver and Hong-Kong, by way of Japan. In 1903 the Canadian Pacific Railway purchased fifteen ships from the Beaver Line, establishing themselves in the Atlantic freight-and-passenger services. In recent years several fine ships, belonging to the 'Empress' and the 'Duchess' classes, have been added to the C.P.R. fleet. The *Empress of Scotland* is a fine vessel of nearly 25,000 tons, and another popular ship, the *Empress of Canada*, 22,500 tons, was re-engined in 1929 The *Empress of Britain*, launched in June 1930, represents the latest development in steam propulsion—single reduction-turbines driven by steam from high-pressure water-tube boilers

The introduction of the marine internal-combustion engine marked a notable development in ship propulsion This engine operates on the same principle as the more familiar petrol engine, but uses crude oil—a fuel that is heavier than petrol, but which is equally effective when vaporized The majority of the heavy-oil marine engines operate on the Diesel principle in which the charge—taken in during the suction stroke—consists of pure air only. This is compressed to about 500 pounds to the square inch, and is thus raised to a temperature sufficiently high to ignite the oil fuel that is sprayed into the cylinder at the end of the compression stroke. The fuel is not exploded as in the petrol engine, but is burned, the flame lasting for about one-tenth of the stroke. The result is that a steady pressure is maintained on the piston for an appreciable period by the hot expanding gases. Of the many advantages of the internal-combustion engine for marine propulsion the most important are the great saving effected in bunker

space, the fact that oil fuel may be taken on board with greater ease and speed than coal, the elimination of stokers, and the reduction of engine-room staff

The first motor-vessels of considerable size were two oil-tank ships, the *Delo* and the *Emanuel Noble*, built in Russia and put into service on the Caspian Sea in 1908. The first sea-going motor-ship was the oil-tanker *Vulcanus* (1180 tons gross), built at Amsterdam in 1910 and fitted with a Diesel engine of 650 h.p These pioneer vessels were followed by many others, and the internal-combustion-engined ship is now competing successfully with steam in ocean transport.

Among the most notable of the Diesel-engined passenger liners is the *Gripsholm*, the first twin-screw ship of her class She belongs to the Swedish-American Line, is 574 feet 6 inches in length and 74 feet in beam, with a gross tonnage of 17,300 Her Diesel engines give a total of 13,500 h.p., and she has accommodation for 91 first,- 355 second-, and 1006 third-class passengers Another fine vessel, the *Carnarvon Castle*—already mentioned—is 655 feet in length, 73 feet in breadth, and 20,000 tons displacement. More recent examples of the possibilities of the motor-ship are shown in the *Asturias* and her sister-ship, the *Alcantara*, of the Royal Mail Steam Packet Company, which carry a total of 1800 passengers and crew They have a length of 655 feet 8 inches, beam of 78 feet, gross tonnage of 22,181, and their Diesel engines develop 15,000 h p

At the time of writing the largest British motor-ship is the White Star twin-screw liner *Britannic*, launched in 1929 She is 680 feet in length, 82 feet in breadth, her gross tonnage is 26,840, and she has accommodation for 1550 passengers. Her Diesel engines consist of two ten-cylinder four-cycle double-acting engines, each of 10,000 h p

This chapter would not be complete without some reference to another interesting development of recent times—the electrically propelled ship. The earliest application of this form of propulsion was made on the Clyde in 1911 with an

experimental launch named the *Electric Arc*. Subsequent developments in this direction have been largely confined to the United States Navy, the most notable examples of this type being the two huge aircraft carriers, *Saratoga* and *Lexington*, each 900 feet in length, 105 feet in width, and with a displacement of over 40,000 tons. On her trial trips the *Lexington* developed 210,000 h p and attained a speed of 34.68 knots (equivalent to over forty miles an hour). The fact that such an enormous weight can be propelled through the water by electric machinery at a speed that would be considered quite good for a motor-car on a smooth road shows that the electrically driven ships has some wonderful possibilities. In 1927 a large electrically propelled passenger-and-freight liner was built for service with the Panama Pacific Line, and the system is now being further extended in the United States merchant service.

It is safe to say that, taken as a whole, water transport has been found cheaper than land transport. The reason for this is that roads—often constructed at great labour and expense—constantly need to be repaired, otherwise they would soon become impassable On the other hand, a 'water road'—river, lake, or sea—changes little or not at all during the history of a nation In the case of a river there may be some amount of silting up, or in the case of the sea there may be coastal differences caused by erosion, but on the whole the water road is much more permanent than the land road.

The cheapness of water transport is made more evident by comparing the capital outlay required for a railway company and that required by a steamship company at the present time. Before the present grouping the largest railway company in the United Kingdom had a capital of £172,000,000, and at the same period there was no single British shipping company with a capital even approximating £10,000,000. At the same period the total value of the mercantile marine of the United Kingdom (comprising no less than 18,250,000 tons of

shipping) was only about £150,000,000. Notwithstanding this fact, this shipping carried about half the ocean transport business of the world. The railway companies are saddled with extraordinarily heavy preliminary expenses in surveying their routes, getting their Bills through Parliament, cost of the land, and the making good of damage. The bulk of their capital expenditure thus goes in preliminary expenses, compared with which the cost of rolling-stock is comparatively small. The capital of the railways in the United Kingdom stood at approximately (in 1930) £1,187,500,000, and two-thirds of this vast sum has been expended in securing the roadway. We see, therefore, that there never can be any comparison between railway rates and steamship freights.

CHAPTER XVI

THE STORY OF THE AIRSHIP

THE story of the conquest of the air is largely one of persistent endeavour coupled with courageous pioneering. Even at a comparatively early period investigation proceeded on two distinct lines On the one hand there were experiments with lighter-than-air craft, and on the other with heavier-than-air machines These two divisions remain in force to-day—we have our giant airships and our great air-liners, each type with influential supporters.

One of the earliest references to ascending in the air by means of a balloon occurs in the writings of Roger Bacon (1214–94), the famous philosopher. Bacon suggested an aerial machine

> composed of a large hollow globe of copper or other suitable material, wrought extremely thin in order to have it as light as possible It must then be filled with ethereal air or liquid fire, and launched from some lofty point into the atmosphere, where it will float like a vessel on water.

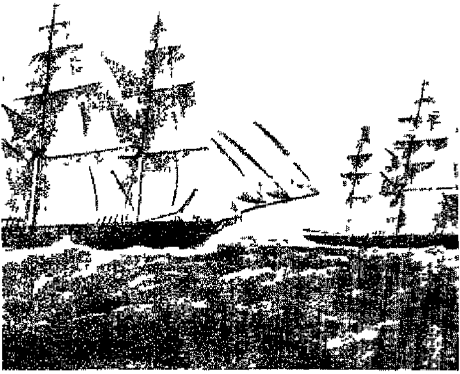
Subsequently there were other similar suggestions based on using hollow metal balls, but the way for lighter-than-air balloons was not made clear until 1766 when Cavendish discovered hydrogen, a gas approximately one-fourteenth the weight of atmospheric air. Priestley, the discoverer of oxygen, published a work entitled *Experiments relating to Different Kinds of Air*, and in 1782 a translation of this book came into the possession of Jacques Montgolfier, a paper-manufacturer of Annonay, near Lyons, France

Montgolfier was interested in chemistry, and when he had read Priestley's comments the idea occurred to him that by

allowing hot gases to pass into a bag of some very light material it would be possible to make this bag ascend He commenced to experiment with a balloon of paper, which was held over a fire of burning straw until filled with hot air, when it was released and ascended to a height of about 1000 feet The success of the experiment so pleased Montgolfier and his brother, Joseph, that they set to work to construct a larger balloon. On June 5, 1783, a public demonstration was given in the market-place, which was thronged with a vast concourse of people In the centre of the square a linen envelope was fixed to a wooden frame, and, a fire of chopped straw having been lighted, the envelope was filled with hot air. At a signal it was released and rose so rapidly that in ten minutes it was at a height of 600 feet. It drifted across country for nearly a mile and a half before coming to earth

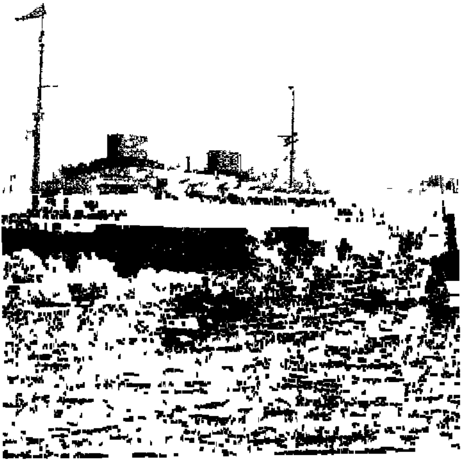
The French Academy, hearing of the experiment, instructed M Charles, Professor of Physics at the Conservatoire in Paris, to construct a balloon and carry out experiments. Charles filled his balloon with hydrogen, which he obtained from the action of dilute sulphuric acid on iron filings. The envelope of the balloon was made of silk dipped in a solution of india-rubber, and 1000 pounds of filings and 498 pounds of acid were used before it was filled with gas. On August 26 the balloon was filled sufficiently to cause it to rise to a height of 100 feet, its further ascent being prevented by ropes.

On September 12 Joseph Montgolfier gave a demonstration with one of his balloons in Paris, repeating the exhibition at Versailles a week later in the presence of Louis XVI On this latter occasion the balloon carried a cock, a duck, and a sheep, this being the first 'passenger' flight ever made. The balloon rose to a height of 1440 feet and descended after being in the air about eight minutes, the 'passengers' being unhurt. This momentous flight led to much speculation as to the possibility of balloons conveying human beings through the air. As no one seemed prepared to take the risk of a first flight the King



CLIPPER SHIPS "TAEPING" AND "ARIEL" PASSIN
IZARD IN THEIR RACE HOME FROM CHINA (1866)

From a contemporary engraving



"BREMEN," ONE-TIME HOLDER OF THE 'BLUE RI
OF THE ATLANTIC

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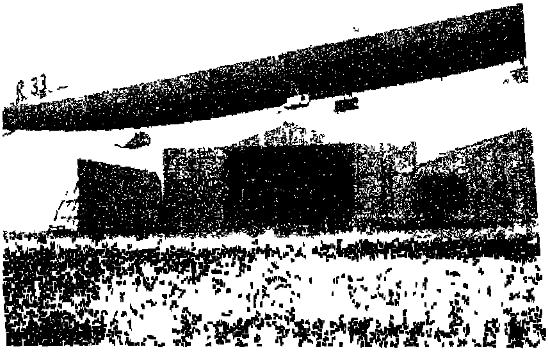
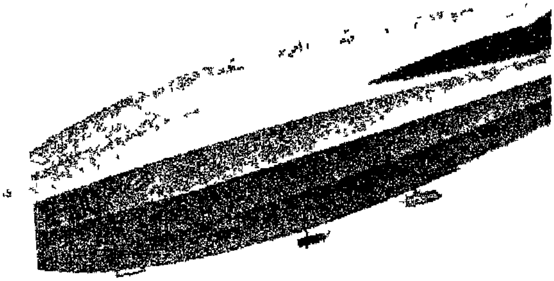


(R33 AT PULHAM AFTER RECONDITIONING



ordered that two criminals who had been sentenced to death should be sent up in a balloon This idea was so repulsive to a young man, Pilâtre de Rozier, that he undertook to make a flight himself On October 15, 1783, a large balloon specially made by Jacques Montgolfier, was inflated in Paris, and de Rozier made several trial ascents while the balloon was held captive. On November 21 he and the Marquis d'Arlandes, who had volunteered to accompany him, made the first free ascent, the balloon rising to a height of 3000 feet. It crossed Paris and came to earth in a suburb after being in the air 20 minutes

In the meantime Charles was improving his hydrogen-filled balloon, and on December 1, 1783, he made an ascent accompanied by a man named Robert, who was greatly interested in the experiments. The balloon rose to a height of 1800 feet, and after an hour and a quarter in the air descended at Nesle some twenty-seven miles away. Robert alighted, but Charles determined to make a further flight, and as a result of the lightened load the balloon shot up to the record height of 9300 feet Charles landed safely thirty-five minutes later three miles away

These experiments attracted the attention of Jean Pierre Blanchard, who for several years had been experimenting with winged flying-machines He made a hydrogen balloon 27 feet in diameter with a small car, equipped with two wings and a rudder, suspended beneath On March 2, 1784, Blanchard ascended in his balloon from Paris, but, owing to a leak in the envelope, had to descend after having risen only a little way The envelope was repaired, and Blanchard ascended again, and, carried by the wind, he passed over the river Passey, ultimately descending near Grandcour, forty-five miles distant

On September 15, 1784, Vincent Lunardi, a native of Italy and secretary to the Neapolitan Ambassador in London, made an ascent from the training-ground of the Honourable Artillery Company. He was accompanied by his friend Biggin, but the balloon failed to rise, owing to unsatisfactory filling. On

Lunardi determining to make the ascent alone, however, Biggin alighted, and the balloon soared above the crowd of spectators, subsequently descending in a cornfield at South Mimms, in Hertfordshire, where Lunardi landed a cat that he had taken up with him He then reascended, and fifty minutes later came down in a meadow at Standon, near Ware.

One of the most remarkable features of all these early efforts was their entire freedom from accident

Naturally the first passenger flight across the English Channel—accomplished by Blanchard, on January 7, 1785—created a great sensation, particularly in France Blanchard ascended from the cliffs at Dover, having with him as passenger an American, Dr Jeffries, who had previously accompanied him on an experimental trip over Kent. The flight had been in progress only a short time when the balloon began to descend rapidly, and ballast had to be thrown out to lighten it By the time the French coast was sighted not only had all the ballast been cast overboard, but practically everything else, including anchors, books, provisions, and even clothing. As a last resort the balloonists were about to fasten themselves to the ropework above the car, intending to cut away the latter, when the balloon approached the forest of Guines and descended so low that Jeffries was able to grasp the branch of a tree The valve was then opened and the envelope deflated, the aeronauts being assisted by some horsemen who arrived on the scene a little later. On the following day Blanchard was fêted at Calais, and the freedom of the city was conferred upon him.

When de Rozier heard of Blanchard's success he at once resolved to accomplish the same feat in the opposite direction—that was, from France to England He constructed a silk envelope, the bottom of which was so arranged that a fire could be lighted beneath to add heated air to the envelope, which was filled with hydrogen at the start. This arrangement was severely criticized by scientists, who declared that

nothing could prevent the hydrogen from catching fire. This criticism did not deter de Rozier from his enterprise, however, and the balloon and apparatus for filling it were conveyed to Boulogne to await a favourable opportunity for the flight The weather was unsuitable for several weeks, but conditions gradually improved, and on June 16, 1785, de Rozier decided to make the trip. Along with a friend, Romaine, he climbed into the car of the balloon, the ropes were released, and the balloon shot up into the air. It then drifted seaward, became stationary, commenced to drift slowly landward, and then, to the horror of the spectators, suddenly collapsed and crashed to earth It came down close to the place where Blanchard had descended after his successful crossing, and those who rushed to the rescue found de Rozier already dead and Romaine so badly injured that he survived him only a short time

This was the first fatal accident in the history of ballooning, and it cast a great gloom over France, resulting in a public outcry against further attempts to excel the achievements of the pioneers. The French Revolution and the wars that followed temporarily relegated the subject of ballooning to the background, and although in 1793 a military corps was founded for carrying out reconnaissance work by means of balloons, little else was done for some time.

In 1803 Count Zambeccari and two friends made a remarkable balloon voyage from Bologna in Italy. Their balloon rose slowly, and after hovering over the town for a considerable time was carried away in a south-westerly direction. It descended to the sea, and, in spite of the fact that the ballast was thrown out, the passengers were up to their waists in water. The start had been made by night, and when daylight broke the Count and his friends found themselves opposite Pesaro They were rescued by sailors in a boat and conveyed to Pola, but the balloon, which rose again when they were taken off, eventually descended somewhere in Turkey. Zambeccari met his death in 1812, when descending after a success-

ful flight from Bologna. The balloon caught fire, and the aeronauts jumped from the car while it was at a considerable height above the ground. Zambeccari was so badly injured that he died on the following morning, but although his passenger was badly hurt, he recovered.

In 1806 James Sadler attempted the first balloon-crossing of the Irish Sea. He ascended from Dublin, but before long the balloon fell into the sea, Sadler being rescued by the crew of a Douglas fishing-boat. The flight was successfully accomplished five years later by Sadler's son Windham, who crossed from Dublin to Holyhead in five hours and a half.

Up to this time balloons had enabled aeronauts to demonstrate that with normal weather conditions flights could be regarded as reasonably safe. It was clear, however, that the balloons were entirely at the mercy of the wind, and that there was no means of insuring flight in any given direction. Until some means could be found of steering a course irrespective of the direction of the wind it was evident that ballooning could never be of any practical value. It was then that aeronauts began to give serious consideration to the problem of devising a dirigible balloon.

In 1863 Nadar, a Parisian photographer, expressed the opinion that aerial navigation could only be accomplished by heavier-than-air machines, and two years later Paul Haenlein, a German, constructed a dirigible balloon that derived its motive power from a gas engine accommodated in the balloon-car. The envelope was cylindrical with cone-shaped ends, and was lined with a thick coating of rubber. It was 164 feet in length, 30 feet in diameter, and its capacity was 85,000 cubic feet, the car being suspended by ropes and slung as close as possible to the envelope. A four-cylinder Lenoir-type 6-h.p. gas engine provided the motive power, the fuel being drawn from the balloon envelope. At its trials this promising airship attained a speed of 10¼ miles an hour, but unfortunately lack of funds prevented further experiments being carried out.

Following the crushing defeat of the French at Sedan Paris was soon entirely cut off from the outside world. Balloons were used to re-establish communication, and many ascents were made. The first was on September 23, when Durouf undertook to carry important dispatches, and after a flight of three hours the balloon came down near Évreux, having safely passed over the enemy lines. After two other balloons had been equally successful in the next four days the Government decided to establish a regular balloon service for the transport of mails from the besieged city. Two balloon factories were built and equipped in Paris to construct balloons of 70,000 cubic feet capacity with cars to accommodate four persons. During the siege of four months sixty-six balloons left Paris and transported out of the city 102 passengers and 9 tons of telegrams and letters. Many of the balloons also carried pigeons, which were subsequently released to fly back to Paris with messages containing military or civil information. Only five of the balloons met with disaster—three fell into the hands of the enemy, and two mysteriously disappeared and were never heard of again.

These successful ascents from besieged Paris reawakened interest in aerial navigation, and in October 1870 Du Puy de Lome, a marine engineer, received a grant of £1600 from the French Government to enable him to construct an experimental dirigible balloon. It had a cigar-shaped envelope, was 118 feet in length and 49 feet in diameter, and the envelope (which was inflated with hydrogen) had a capacity of 122,000 cubic feet. The car was large enough to accommodate a crew of fourteen men, four of whom worked a propeller 30 feet in diameter. The rudder consisted of a triangular sail hoisted at the stern and immediately below the envelope. When tried at Vincennes on February 2, 1872, the dirigible ascended with a full complement of passengers, and, having been set at right angles to the wind, it was successfully steered (at a speed of about six miles an hour) along a course that deviated some ten

degrees from the path of the wind. Later it descended safely about ninety miles from Paris, the trial showing that under favourable conditions a lighter-than-air balloon could be controlled during flight by means of a screw-propeller and rudder

In 1897 an Austrian engineer named Schwarz built the first aluminium dirigible balloon, 134 feet in length and 42 feet in width The body consisted of a lattice framework of aluminium tubes, covered with aluminium sheeting $\frac{8}{100}$ inch thick Inside the aluminium envelope was a silk bag, which was filled with hydrogen and expanded so that it expelled the air from the envelope. When the envelope was filled the bag was torn to pieces and pulled out. An aluminium car slung beneath carried a 12-h.p. benzene motor operating four propellers, two for vertical and two for horizontal movement Four years were required to design and build this dirigible, and about £4000 was expended on the work At the trial the dirigible, with one engineer on board, rose to a height of 82 feet. After remaining stationary for a few minutes it commenced to fall swiftly, for the engineer, having found he was unable to navigate the airship alone, became frightened and opened the valve. There were no safety devices to check the fall of the craft, which sped downward with increasing velocity The engineer jumped out of the car just before it struck the ground and escaped with only slight injuries, but the dirigible was destroyed.

In 1897 Santos-Dumont, a wealthy young Brazilian on a visit to Paris, made an ascent in a balloon, an experience that so thrilled him that he ordered two balloons to be constructed for his own use. At this time motor-tricycles were very popular, and it occurred to Santos-Dumont that by using a tricycle engine in a balloon he might evolve an effective airship. He resolved to construct an elongated dirigible of sufficient power to lift himself and whatever else might be necessary in the way of basket, motor, fuel, and ballast The envelope for the dirigible was constructed of Japanese silk, and was 82½ feet

in length and 11½ feet in diameter, having a capacity of 6354 cubic feet The rudder, a triangular steel frame covered with silk, was attached to the stern The airship was made to cant upward or downward—for climbing or descending—by two sandbags, which, suspended fore and aft, could be manipulated to alter the centre of gravity when necessary. The first attempted flight ended in disaster, the airship being blown against some high trees and the envelope torn Two days later, however, on September 20, 1898, a successful ascent was made from the Zoological Gardens, Paris. The airship was manœuvred to right and left and up and down, in order to test the steering-gear. It then ascended to a height of 1300 feet, but only with difficulty, owing to the gas in the envelope contracting with great rapidity

In the following year Santos-Dumont constructed a second and larger dirigible with a capacity of 7000 cubic feet. On May 11 a trial was made, but again the contraction of the gas caused the airship to fall rapidly, and it was wrecked on the top of some trees. Four other airships followed in rapid succession, and with the sixth Santos-Dumont (on October 19, 1901) won a £4000 prize offered by M Deutsch, a member of the Paris Aero Club, to the first man who should succeed in making an aerial voyage round the Eiffel Tower, returning to the starting-point at Saint-Cloud within half an hour of setting off. The winning effort was accomplished with a narrow margin of 30 seconds This airship had a capacity of 22,239 cubic feet, a lifting-power of 1518 pounds, and was fitted with a four-cylinder 12-h.p. engine

In the meantime important experiments were being made by Count Ferdinand von Zeppelin, a retired German Army officer, who had come to the conclusion that Schwarz's ill-fated airship had been constructed on sound principles. "I intend to build a vessel," Zeppelin declared,

> that will be able to travel to places that cannot be approached—or only with great difficulty—by other means of transport, to undis-

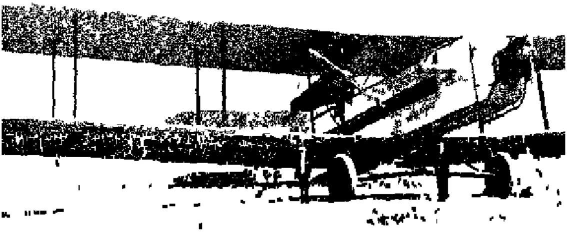
> covered coasts or interiors, in a straight line across land and water where ships are to be sought for, from one fleet station or army to another carrying persons and despatches for observations of the movement of hostile fleets or armies, but not for actual participation in actual warfare My balloon must be able to travel several days without renewing provisions, fuel, or gas It must travel quickly enough to reach a certain goal in a given number of days, and must possess sufficient rigidity and non-inflammability to ascend, travel, and descend under ordinary conditions.

This announcement was received with much scepticism and some ridicule, for it was regarded as most improbable that an efficient airship could be evolved by a man who had devoted his life solely to military affairs. Zeppelin had the courage to support his convictions, however, and sold his family estate, withdrew his life-savings, and, supplementing the money from these two sources with his modest army pension, succeeded in raising £30,000. A company was then formed with a capital of £40,000 one half of which Zeppelin contributed. It was decided to construct and house the airship in a floating workshop on Lake Constance, and a timber shed floating on ninety-five pontoons was built. When completed the airship was 390 feet in length and about 30 feet in diameter. The outer envelope was of silk specially treated and stretched over an aluminium framework. This was divided into sixteen small compartments each containing a hydrogen-filled balloon. A sliding weight on a steel cable altered the centre of gravity of the airship, and allowed it to be manipulated in a manner similar to that used by Santos-Dumont. Two cars, 5 feet by 3 feet, slung beneath the envelope each contained a 16-h p Daimler benzene motor working two propellers. Sufficient fuel was carried for a ten-hours' flight

The building of the airship occupied two years, and on July 2, 1900, a trial flight took place. Count Zeppelin and four assistants were on board. Some minor accidents led to the flight being prematurely concluded, but on a further test

XXX

1. THE TWELVE-ENGINED DORNIER X



2. IMPERIAL AIRWAYS AIR LINER

during the following month a speed of 30 feet a second was attained. Eventually the airship collapsed, but the construction of a better one was commenced, and on June 17, 1906, this second Zeppelin attained a height of 15,000 feet. Unfortunately it was destroyed the following night by a high wind, while at anchor. Further Zeppelins were built, each containing improvements in various details and being equipped with motors of greater power than its predecessor. So convincingly did they demonstrate the reliability of this type of aircraft that regular airship transport services were commenced in Germany. At the time of the outbreak of the War in 1914 provincial airship-travel was well established in that country.

Although Zeppelin did not confine his attention to developing only passenger-carrying airships—he recognized the enormous possibilities of dirigibles in warfare—he remained faithful to the principle of a rigid framework enclosing a series of gas-filled ballonettes. In 1912 he constructed the L 1, a naval airship, 514 feet in length and 47 feet in diameter. It contained seventeen small hydrogen-filled balloons, and had a capacity of 776,600 cubic feet It was fitted with three Maybach engines, giving a total of 540 h.p , and under favourable conditions it attained a speed of 50 miles an hour The sliding-weight arrangement was replaced by two pairs of plane-sets, one forward and the other aft, and there were two platforms on the top of the airship for mounting machine-guns.

While the rigid airship, capable of long-distance flight, was thus being developed in Germany, there was comparative inactivity in airship matters in England. Such experiments as were carried out were made to determine the possibilities of airships in connexion with military operations Either non-rigid, or semi-rigid airships were in favour, the latter being the ordinary type of elongated balloon similar to that employed by Santos-Dumont, but strengthened by the addition of a keel

along the base of the envelope. The first British airship, built in 1907 at the Royal Aircraft Establishment at Farnborough, was of this type. Subsequently several other non-rigid airships were built or purchased by the Army authorities, but they were not very successful.

The first rigid airship to be built in Great Britain was constructed in 1911 by Vickers, Ltd. It was built for the Admiralty, and was known variously as the *Mayfly* and "Naval Airship No. 1" It was 512 feet in length, 48 feet in diameter, and had a capacity of 660,000 cubic feet. Two cars slung 200 feet below the envelope each accommodated a 180-h p Wolseley motor The *Mayfly* represented much thought and money, but its career was of short duration, for it was wrecked while being taken out of its hangar at Barrow-in-Furness

In 1913 the Admiralty purchased an Astra-Torres airship from the Astra Company of France. This airship was the invention of a Spanish engineer named Torres, who, having unsuccessfully endeavoured to convince the Spanish Government of the merits of his invention, sought the co-operation of the Astra Company. The distinctive feature of the invention was that practically the whole of the suspension system of the airship was arranged inside the envelope, thus reducing the air resistance of external suspension ropes to a minimum The airship purchased by the Admiralty (240 feet in length and 46 feet in diameter) was fitted with two 200-h.p Chenu motors, which were capable of propelling it at a speed of over 51 miles an hour. The car accommodated a crew of seven. In 1914, after the outbreak of war, a second and slightly larger airship of the same type was purchased, and, together with the airship acquired in the previous year, was engaged in patrolling the Channel in connexion with the transport of troops to France.

During the War coastal patrol work and escort duty necessitated England's equipping herself with a considerable number of small airships, and a type of small non-rigid airship

similar to the *Delta* was evolved. They were officially styled the "S.S." (Submarine Scout) class, but were more familiarly known as 'blimps.' They were 143 feet in length, 27 feet 9 inches in diameter, and had a capacity of 60,000 cubic feet Various types of engines were used, and in all cases a speed of over 50 miles an hour was attainable. New and improved types of 'blimps' were produced from time to time, each succeeding type having greater speed and flying range. In 1916 the "Coastal" class was evolved, and in the following year an improved edition of non-rigid airship, known as the North Sea type, was designed for scouting in the North Sea These North Sea airships were 262 feet in length and 55 feet in diameter, had a capacity of 360,000 cubic feet, and carried a crew of ten. They were fitted with two 275-h.p. Rolls-Royce Falcon engines, giving a speed of 60 miles an hour, and had a greater flying range than the largest of the earlier 'blimps.'

In the meantime Germany was building Zeppelins with all speed, and at the close of 1914 two factories were in operation. One of these was at Berlin and the other at Friedrichshafen, and each was capable of producing two Zeppelins a month The practicability of rigid airships was conclusively demonstrated to England in the course of Zeppelin bombing raids. Although several airships suffered at the hands of the British airmen during the first two years of the War, all were completely destroyed, so that they could not be examined. On the night of September 24, 1916, a Zeppelin (L 33) was brought down near Colchester, and although her crew set fire to her, only the outer cover and the gas-bag were destroyed. The structure, which was practically undamaged, provided British engineers and designers with a long-desired opportunity of making a detailed study of Zeppelin construction. The streamline form, employed in this Zeppelin for the first time, was adopted by the British authorities for the rigid airships they subsequently designed. Incidentally, it may be mentioned that, while introducing the best points of the

Zeppelin, the British airships also embodied many modifications and improvements that were the work of British designers.

The Great War was well advanced before the British rigid airships were available for service, and several of them were still under construction at the time of the Armistice. The first of these rigid airships to attract public attention was the R 34, which had a framework of duralumin and carried four cars, each 30 feet in length, slung beneath the huge hull It was driven by five 250-h p. twelve-cylinder Coatalen Maori IV Sunbeam engines, coupled to four propellers, three 17 feet 6 inches and one 19 feet 6 inches in diameter.

In 1919 the R 34 made an historic flight across the Atlantic and back, carrying 4900 gallons of petrol (at the start) and a crew of thirty-two, who did four-hour turns of duty. The flight began early in the morning of July 2 from East Fortune, in Scotland, and during the greater part of the outward trip the airship flew at an altitude of 1500 feet. As she approached the Newfoundland coast she passed over innumerable icebergs, and, after encountering dense fog and a severe thunderstorm, arrived safely at Long Island, New York, where she received a great welcome The total time for the flight of 3120 miles was 108 hours 12 minutes. The return trip was accomplished without incident, the airship making better time and reaching Pulham airship station in 3 days, 3 hours, and 3 minutes. The R 34 came to a tragic end in 1921, when she was blown against the cliffs at East Fortune She managed to fly to Howden, however, but during the following night a strong wind arose and she sustained such severe damage as to become a total wreck.

Another British airship, the R 38, uncompleted at the time of the Armistice, was sold to the United States Government, who sent a crew to England to fly her across the Atlantic. On August 24, 1921, a number of the American crew, together with many aeronautical experts, were on board for a test flight When the airship was over the river Humber at

an altitude of 1200 feet the rudder was put 'hard over.' The framework of the airship, proving unequal to the severe strain imposed by this manœuvre, snapped near the stern Some of the petrol-tanks were fractured; an electric spark ignited the fumes, the hydrogen in the balloons caught fire, and in a moment the blazing airship was in the river. Only five of the forty-nine on board were rescued.

Another airship, the R 33 (Plate XXVIII, *A*), built at Howden, near Selby, was 670 feet in length and 79 feet in diameter, with a capacity of nearly 2,000,000 cubic feet. The five cars provided accommodation for a crew of twenty-three and five 250-h.p. motors, the combined power of which gave the airship a maximum speed of 65 miles an hour. After experimental flights had been made the airship was deflated and stored away until May 1924, when it was reconditioned at Bedford This process was completed on April 2, 1925, and the airship was flown to Pulham. A fortnight later a gale arose, and on the morning of April 16 the fitting attached to the masthead fractured, and the airship was adrift with two-thirds of her crew on board. Despite the fact that the engines were quickly started up, the gale drove her rapidly eastward. Realizing that it was hopeless to attempt to fight the gale, the officer in command kept her nose in this direction, with the result that she was blown across the North Sea to the Coast of Holland She was constantly in wireless communication with the Air Ministry, however, and at four o'clock in the afternoon reported that she was 25 miles W N.W. of Texel. Two and a half hours later she passed over Ymuiden, and at 8.30 P.M stated that she had commenced to make her way home. Progress was very slow, and she did not arrive at Pulham until 3 20 P M. on April 17.

The R 36, which was not completed when the War came to an end, was the first British airship to be equipped with a saloon. She was 672 feet in length and 78 feet 9 inches in diameter, and had a capacity of 2,101,000 cubic feet. When

built she was intended for use in the War, but after the Armistice her internal arrangements were redesigned so that she could be finished as a commercial airship. The saloon was situated below the keel, and contained a kitchen and accommodation for thirty passengers.

The most recent British airships were the R 100 and the ill-fated R 101. The former (Plate XXVIII, *B*), which was constructed at Howden, was 709 feet in length, 130 feet in diameter, had a capacity of over 5,000,000 cubic feet, and a total lifting power of 158 tons The six 700-h p. Rolls-Royce engines gave the airship a maximum speed of 82 miles an hour. The R 101 was built at the Royal Airship Works at Cardington, and was completed during 1929. She was 780 feet in length, with a diameter of 132 feet, and had a capacity of approximately 5,000,000 cubic feet The passenger accommodation was situated on two decks inside the airship. The upper deck included a lounge 60 feet in length and 32 feet in width, flanked on either side by promenades 7 feet 6 inches wide, from which passengers were able to obtain an outward view through inclined windows fitted in the outer cover of the airship. There was also a dining-room for fifty persons, and a number of double-berthed sleeping compartments. The equipment of the lower deck included an electric kitchen and a ventilating chamber. The airship was driven by Beardmore 'Tornado' heavy-oil engines, arranged in five independent power units She was destroyed by fire at Beauvais, France, with a loss of nearly fifty lives, on October 5, 1930.

America's first rigid airship, the *Shenandoah*, was constructed at Philadelphia by the United States Navy in 1923. She was 680 feet in length and 79 feet in diameter, and was fitted with six six-cylinder 300-h.p. engines, each housed in a separate car beneath the hull. She had a maximum speed of 65 miles an hour, and carried a crew of twenty-two. On January 16, 1924, after a four-days test, she was torn from her mooring-tower at Lakehurst, New Jersey. Sufficient of the crew were

on board to navigate the airship, and, riding out of the storm successfully, she was back again and safely housed at Lakehurst early the following morning In September of the following year she encountered another terrific storm, and, breaking in two, was completely wrecked. Another United States airship, the *Los Angeles*, of almost the same dimensions as the *Shenandoah*, was completed at Friedrichshafen in 1924. She was built by the Zeppelin Company, and was officially designated ZR 3, being allocated to the United States by the Reparations Commission, to be used for civil and commercial purposes only. After a successful Atlantic crossing from Friedrichshafen to Lakehurst (5006 miles in 81 hours 17 minutes) the ZR 3 was renamed *Los Angeles*. She has five twelve-cylinder Maybach engines, giving her a maximum speed of 78 miles an hour.

The world's most notable airship flight is that of the *Graf Zeppelin*, which in 1929 circled the globe. This airship, which is officially designated LZ 127, is 771 feet in length and 100 feet in diameter, and has a capacity of 3,707,500 cubic feet Fitted with five Maybach engines giving a total of 2650 h p, she has a maximum speed of 80 miles an hour, and in normal atmospheric conditions can carry a load of 107 tons. She carries a crew of twenty-six, and her passenger accommodation includes a lounge, a dining-saloon (measuring 20 feet by 16 feet), and an electric kitchen She was built at Friedrichshafen at a cost of £225,000, and on August 8, 1929, left Lakehurst to commence her famous flight round the world. No previous travel by airship did as much as this flight to establish confidence in the future possibilities of this form of transport for long overland and oversea routes. She covered a distance of 21,000 miles in just over three weeks, including nine days 'resting' and refuelling at Friedrichshafen, Tokyo, and Los Angeles Her trip eastward from Lakehurst to Friedrichshafen was made in the remarkably quick time of 55½ hours, which not only is a record Atlantic airship crossing, but indicates to some

extent the great time-saving possibilities of aerial transport. The *Graf Zeppelin* made her initial flight to Lakehurst under the flag of the Hamburg-American Line, and it was subsequently announced that this house would actively associate themselves with the construction of an improved airship of the *Graf Zeppelin* type, specially designed for Atlantic service.

A contract has been signed between Dr Hugo Eckener, the pilot of the *Graf Zeppelin* on this and other flights, and certain American companies to further a commercial airship service across the Atlantic The *Graf Zeppelin* has made fairly regular journeys from Friedrichshafen to Rio de Janeiro When the *Hindenburg*, a much larger airship, is completed it is proposed to inaugurate a regular service to Rio, then to Washington, and back to Europe

CHAPTER XVII

THE STORY OF THE AEROPLANE

APPARENTLY man has been attempting to fly with heavier-than-air machines from the earliest times, for there are fables of winged flight in the mythology of ancient Greece and Rome, and of Scandinavia and the East. In Great Britain there is a legend of a flight by Bladud, the mythological tenth king of Britain and the father of the equally mythical King Lear. Bladud, who is supposed to have died in 852 B.C., is said to have made himself a pair of feather wings with which he attempted to glide, but, losing control, came to earth on the temple of Apollyon in the city of Trinovantum (London). About A.D. 1020 Oliver of Malmesbury fitted wings to his hands and feet, and, jumping from a tower, maintained himself in the air sufficiently long to glide for a furlong, when he fell to earth, breaking his limbs. At a later date John Damain, a favourite of King James IV of Scotland, endeavoured to perform a similar feat. He jumped from the top of Stirling Castle, and ingeniously ascribed his failure to soar to the fact that his wings contained hen's feathers instead of being wholly composed of eagle's feathers!

In 1660 a French acrobat named Allard decided to attempt a flight, using artificial wings, from the terrace of Saint-Germain to the woods of Vesinet. The attempt was made in the presence of King Louis XIV and a large crowd of people, but, shortly after taking off, Allard's strength failed him, and he fell to earth, receiving severe injuries Eighteen years later a French locksmith, named Besnier, constructed an apparatus consisting of two long wooden poles, at the ends of which were wings made from muslin and hinged so that they could

be flapped up and down A pole was carried across each shoulder, and from the rear extremity of each pole a cord was fixed to the corresponding foot. At first Besnier only jumped from chairs and tables to the floor, but as he gained confidence he increased the height, jumping from the lower windows of his house. Eventually he jumped from an attic window and, sailing over the roof of a neighbouring cottage, came safely to earth. In 1742 the Marquis de Bacqueville made a number of practice flights with a pair of artificial wings attached to his hands and feet, but in an attempt to fly across the river Seine he crashed on to the deck of a barge and broke a leg. Thirty years later his example was followed by the Abbé Desforges, who, in his 'flying chariot' (consisting of a pair of wings and a small horizontal sail), fell to earth in a similar manner

As we have seen, the attention of aeronauts about this time was turned to the development of balloons, but the idea of bird-like flight was not forgotten, and early in the nineteenth century it was revived In 1809 a Viennese watchmaker, named Degen, produced an apparatus consisting of two parachutes arranged so that they could be folded or extended as desired. With this strange apparatus Degen made several public flights, on one occasion rising to an altitude of 54 feet, and after flying in different directions glided safely to earth. Degen's activities brought him to the notice of one of the greatest pioneers of aviation, Sir George Cayley, some of whose essays are still considered to be the finest ever written on aerial navigation. Sir George experimented with gliders in 1808, combining his theoretical and scientific knowledge with practical experiment. He became convinced that practical flight would not be possible until a suitable mechanical power was evolved. He suggested that a steam-engine might be used, but the engines of Boulton and Watt, in use at that time, were far too heavy, and the necessary mechanical power was not forthcoming until many years later

About 1845 it occurred to William S. Henson that an

oscillating wing was not necessary for flight, and that the requisite buoyancy might be obtained equally well with a rigid type of wing He designed an aerial carriage with rigid planes consisting of a bamboo framework covered with oiled silk (Plate XXIX, *A*) At the rear of the planes were two large twin-bladed propellers operated by a 230 h.p. steam-engine. Directly behind the car in which this was accommodated was a fan-shaped tail that could be moved upward or downward or closed altogether by means of an arrangement of cords or pulleys. Beneath the tail was a vertical rudder, by which the machine could be steered to the left or to the right Henson never built this imposing machine, but subsequently he and another experimenter, John Stringfellow, made a model of it and carried out various tests These were not altogether successful, however, for the model was too light to withstand even gentle air currents. Later Stringfellow achieved some success with model aeroplanes, but, as far as is known, he never attempted to build a full-sized machine.

During the nineteenth century it seems generally to have been believed that the problem of flight by means of heavier-than-air machines could only be solved by the use of some type of huge, bird-like wings Inventors studied the movement of birds in flight and endeavoured to imitate them by means of gliding flight with motorless machines After several years experimenting a French sailor, Le Bris, succeeded (in 1855) in evolving a machine built on the lines of an albatross, and with it he made successful soaring flights The extended wings of his machine measured 50 feet, and beneath was suspended a canoe-shaped body made of light ash and covered with water-proof cloth in case of a descent on water. The machine was launched from a peasant's cart, to which it was fixed by a rope terminating in a slip-knot held by Le Bris, who stood in the car of the machine. The cart moved against the breeze, and, Le Bris giving a signal, the driver put the horse into a trot At the same time the inventor loosened the slip-knot and depressed

levers that caused the front edges of the wings gradually to elevate. Almost immediately the machine rose steadily to a height of nearly 300 feet, and flew for a distance of about 200 yards Then Le Bris saw that the rope he had detached from his wrist had wound itself around the driver of the cart, with the result that the man had been lifted from his seat and was suspended in mid-air! Le Bris promptly manipulated his levers and brought the machine back to earth so successfully that the driver was not hurt The machine was ultimately wrecked during another trial, the inventor escaping with nothing worse than a broken leg. A second machine was constructed in 1869 and made some successful trial flights, but it too was wrecked in a high wind

One of the most thorough investigators of bird-flight was Otto Lilienthal, who in 1895 built a glider with a span of 22 feet It had two concave wings the curvature of which had been carefully calculated so that they should bear the same relation to the body of the pilot as the wings of a bird bear to its body. The wings were made of linen stretched over a framework of willow, and the body of the machine consisted of a horizontal hoop of willow with two long willow rods extending in a fore-and-aft direction on each side The main frame terminated in a small horizontal wing, hinged separately to a vertical plane that was attached rigidly to the body of the machine. As Lilienthal was unable to discover a suitable elevated area of land from which to carry out his experiments he built a large mound of earth almost 100 feet in height In practice the glider was hauled to the summit of the mound, and Lilienthal, having secured himself in the pilot's seat, ran downhill against the wind. As he gained speed the upward pressure of the wind on the underside of the wings increased until it overcame the weight of the man and the glider Then Lilienthal was lifted off his feet and carried through the air until the glider lost speed and descended to earth again Control was effected by the pilot's shifting the position of his

body to counteract any deviation from the horizontal In a later glider, in which two small wings were placed one above the other, instead of two large wings side by side, Lilienthal found that he could take off from the hill-top without having to make a preliminary run downhill as before.

Altogether Lilienthal made over 2000 successful glides, and when he considered he had learned all that gliders could teach him he turned his attention to perfecting a power-driven machine. Accordingly he installed a petrol motor in a machine, completing this work by August 1896. On the 9th of that month he indulged in a final flight in his glider before venturing aloft with the power-driven machine. On this occasion he launched himself and sailed through the air for a distance of 200 yards, when a sudden gust of wind caught the glider. Lilienthal lost control, and the glider crashed to earth from a height of 250 feet, so severely injuring the intrepid pilot that he died in a very short time.

In the meantime Hiram Maxim was busily engaged in England on the construction of a mechanically propelled heavier-than-air machine This resembled a gigantic kite, and consisted of a structure of steel tubes braced with wires and connected to horizontal wings (Plate XXIX, *B*) The central plane had a spread of 120 feet, and in addition there were fore-and-aft elevating-planes. The propelling machinery, carried on a platform suspended from the principal plane, consisted of a 350-h p. compound steam-engine with a Thornycroft boiler heated by a naphtha burner. The engine weighed about 600 pounds, in addition to which the machine carried some 600 pounds of water and 200 pounds of naphtha. The two propellers were 5 feet 2 inches in width and 17 feet 10 inches in diameter In order to insure safety during the experiments, the lift of the machine was limited by means of inverted rails On July 21, 1894, the engines were started up, and, with three people on board, the machine lifted clear of the lower rails for a distance of about 600 feet. Owing to the breaking of one of

the rear axle-trees the machine rose considerably above the track, but came safely to earth. It was then seen that at this place the wheels had embedded themselves in the soft turf without leaving any other marks, thus showing conclusively that the machine was completely suspended in the air.

Several other experimenters were at work about the same time In England there was Pilcher, who built his first glider in 1895. He visited Lilienthal in Berlin, and on his return built several gliders These he flew successfully, but his experiments were cut short in 1899, when he was killed while gliding In America Octave Chanute made some successful gliding flights in 1896–97 About the same time Samuel Langley commenced experimenting with engine-driven models In 1903 he built a full-sized aeroplane, the engine of which, a five-cylinder radial, specially designed by Charles M. Manley, weighed 125 pounds, and developed about 50 h.p. On October 7, 1903, everything was ready for a trial flight, but this was unsuccessful owing to the machine fouling its launching gear when taking off.

The first experimenters to achieve successful flight in a power-driven machine were Wilbur and Orville Wright, of Dayton, Ohio. At the time when the brothers first became interested in aeronautics (1896) they were the joint proprietors of a small cycle-shop, and their interest was aroused by reading of the experiments of Lilienthal. They soon read all the books they could obtain dealing with the science of flight and then commenced to build model gliders. After some experiments with these they made a full-sized glider (in 1900) embodying several original features (Plate XXIX, *C*). Stability was obtained by means of a horizontal rudder in front of the main planes, and the equilibrium of the machine was maintained by 'warping' the wings, the pilot pulling cords connected to the rear edge of the wings. The brothers carried out their experiments at Kitty Hawk, an isolated part of the coast of North Carolina, and here they made over a hundred gliding flights

during 1900–1, and in a better machine in the next two years.

When they learned to control their glider the Wrights turned their attention to the construction of a mechanically propelled machine. Failing to find a petrol-motor that was suitable for their purpose, they set to work to construct their own (it developed 25 h.p., and weighed about 250 pounds), which they fitted into an aeroplane in 1903. In appearance the machine resembled their earlier gliders, with the elevators, rudder, and warping of the wings controlled by levers situated on each side of the pilot's seat in the front of the machine. Instead of a wheeled under-carriage, two skids, or runners, were fitted beneath the machine, so that a launching device had to be used to start the aeroplane on a flight. The first flight on this machine was made on December 17, 1903. Both the brothers were eager to win the distinction of piloting the first flight, and they settled the matter by tossing. Orville won, and started the engine. With a roar the aeroplane moved slowly forward, Wilbur keeping pace with it at first. The machine rose to an altitude of 120 feet and remained aloft for 12 seconds. In that short space of time it was proved that a heavier-than-air machine, capable of carrying a man, could be flown successfully. Three further flights were carried out on the same day, the last one being of 59 seconds' duration, during which the machine travelled a distance of 852 feet. From 1904 onward they continued to experiment with power-driven machines, continually effecting improvements. In 1905 they had eclipsed all previous records by making a successful flight that lasted 30 minutes, during which time a distance of 24½ miles was covered.

In 1908 Wilbur Wright visited France, where he found that considerable progress also had been made. In 1906 Santos-Dumont had made a trial flight on a heavier-than-air machine fitted with a petrol engine, had risen to a height of about 15 feet, and travelled a distance of 700 feet in 21 seconds. On

March 30, 1907, Charles and Gabriel Voisin had flown a distance of 50 yards on a biplane glider of their own construction In the following year the Voisin brothers carried out several successful experiments with a biplane equipped with a 50-h p engine Henry Farman, who previously had designed a glider, had commissioned the Voisin brothers to build him a power-driven aeroplane. With this machine, which was equipped with an eight-cylinder 49-h.p. Antoinette petrol-motor, Farman had made several flights. His first efforts were but brief hops, but gradually he became more proficient, and in less than a year he had succeeded in flying a distance of 800 yards On January 13, 1908, he had covered a distance of one kilometre, winning a prize of £2000. In July of the same year he had remained in the air for more than twenty minutes, and in September for forty-two minutes, during which time he flew about 24½ miles.

It was at this period that Wilbur Wright arrived from America. At first he was given a rather cool reception, for the French public were unaware of the definite progress that he and his brother had made, but things assumed a very different aspect when he proceeded to beat the French airmen on their own ground. His machine was equipped with a 24-h p. four-cylinder motor, and was provided with launching skids. On September 21, 1908, he beat all previous records by flying for 1 hour, 31 minutes, 25 seconds, during which time he travelled fifty-six miles On December 31 he accomplished a flight that lasted for two hours

The first man to make a free flight in England was S F Cody, an American, whose earliest experiments were made with man-lifting kites. In 1908 he turned his attention to the construction of a power-driven aeroplane, and in the summer of that year he made his pioneer flight

Among other pioneers in England were Handley-Page, Sopwith, de Havilland, Short, and Blackburn. All made notable contributions to the development of the heavier-than-

air machine, and each name is prominent to-day in connexion with aircraft-manufacture.

A definite forward step in the conquest of the air was made on July 25, 1909, when Louis Bleriot flew from France to England on a machine of his own design. The machine, which was a monoplane, was fitted with a three-cylinder 25-h.p. Anzani engine, and the flight was made at a speed of 36 miles an hour. In July of the following year the Hon. C. S. Rolls made the first double flight across the Channel, flying (in forty-eight minutes) from Dover to Barraques, in France, and returning to Dover without landing. The double journey of fifty miles was accomplished in less than 1½ hours.

In 1906 *The Daily Mail* had offered a prize of £10,000 for a flight to be made in 24 hours from London to Manchester, but it was not until four years later that an attempt was made to win this prize. Then two contestants came forward—an Englishman, Claude Grahame-White, and a Frenchman, Louis Paulhan—each flying Farman machines. Grahame-White started on April 23 from Park Royal and, flying to his first stop, Hill Morton (75 miles distant), established a world record for a cross-country flight. Continuing, he landed at Lichfield, but here his machine was damaged by a gale, and he had to return to London. Hearing of Paulhan's start from Hendon on April 27, Grahame-White made a new start in the endeavour to beat him, although the Frenchman had a 50-mile lead. Grahame-White was unlucky, however, for his engine failed, and Paulhan, completing the flight within the specified time, was awarded the prize.

The next big event, a 1000-mile race round Britain, was organized in 1911. Of the nineteen starters four finished the course, the race being won by André Beaumont (his real name was Captain de Conneau, of the French Army), whose flying time was just under 22½ hours.

By this time pioneer work with heavier-than-air machines had been done, and further progress was but a matter of

development in design The War gave flying a great impetus and proved conclusively the practicability of the new means of rapid transport. By the end of the War the aeroplane had reached an advanced state of development, although naturally the machines were designed for military requirements. In the post-War period a commercial type of aeroplane evolved, however, and resulted in the establishment of the international commercial air transport services that we know to-day.

In recent years considerable attention has been paid to the construction of all-metal aircraft, for which duralumin was at first largely used Duralumin, which is a non-rusting alloy combining the lightness of aluminium with the strength and toughness of steel, is used for the construction of every part of these aircraft. Duralumin plates are used in the place of fabric for covering the wings and fuselage, no dope or other treatment being necessary to make the metal proof against climatic conditions. Size for size, duralumin machines are lighter than the ordinary type, and in quantities they are cheaper to build. They have a higher wing-loading and consequently a better speed and general performance. All metal aeroplanes (with the exception of the wings) have also been made from a tensile alloy steel, which in strip is formed into sections by passing it through a number of sets of rollers by which it is drawn through dies As with duralumin, one of the main advantages of steel construction is a saving in weight, a steel aeroplane being about four-fifths the weight of a corresponding machine in wood. The weight thus saved can be used either to increase the useful load that the aeroplane can carry, or to increase its speed and rate of climb with a given engine-power.

In 1929 an important development in heavier-than-air machines was marked by the construction of the *Dornier X* flying-boat (Plate XXX, *A*). This type has none of the limitations that render the aeroplane proper so unsatisfactory for long ocean flights, and its design and high propelling

power make it much more fitted to battle with contrary winds than is the case with large airships. The *Dornier X* is able to take off from the water within one minute even when fully loaded. Accommodation is provided for a hundred passengers as well as a crew of ten. Originally she was fitted with twelve 250-h.p. 'Jupiter' engines which gave her a speed of 110 miles an hour, and it is claimed that she should be capable of effecting the Atlantic crossing in thirty-hours. Late in 1930 she made a flight to England and to Portugal, where fire destroyed one of her wings. It had been intended that she should fly across the Atlantic, but the fire caused a delay that made it impossible to accomplish the flight before bad weather set in.

One of the greatest problems that has arisen in man's efforts to conquer the air is the question of vertical flight. No doubt in the future a machine will be evolved that will be able to hover in the air, or to land directly on a given spot. The advantages of such a machine would be enormous—for instance, it would be able to rise and descend without the necessity of special landing-grounds, and to take off from or land on the deck of a steamer or warship. Many attempts have been made to solve the problem of vertical flight, the machines concerned being divided into two main types—(1) ornithopter, and (2) helicopter. In the former type (the name of which is derived from *ornithrios*, 'of a bird,' and *ptera*, 'wings') the wings flap up and down as in the case of a bird in flight. Such machines have been built, but none has yet actually flown, although some have succeeded in moving a little way along the ground. The helicopter (which derives its name from *helix*, 'a screw,' and *ptera* 'wings') is a machine the wings of which revolve on a vertical axis or shaft, so that, in effect, these machines may be said to screw their way up into the air. This is, of course, a very different movement from that of the aeroplane, which derives its forward motion from a screw on a horizontal shaft, giving a forward speed sufficient for the wings to lift the

machine from the ground. The best-known helicopter is that of Louis Brennan (the inventor of the famous high-speed mono-railway that bears his name), which was tested with great secrecy some years ago by the Air Ministry, but did not meet with success

A few years ago a Spanish engineer, Señor Don Juan de la Cierva, designed the "Autogiro" This consists of an ordinary aeroplane having in place of wings four windmill-like blades or rotors mounted horizontally above the fuselage The rotation of the rotors is started by deflecting the slip-stream from the airscrew on to them, after which the passage of the machine through the air keeps them in motion. Thus, even when the Autogiro has ceased to move forward forces continue to act on the wings, making it impossible for a 'stall' to occur. The machine can take off after a short run, usually of about 30 yards, while no landing run or landing speed is required in still air. The Autogiro is flown in a similar manner to an ordinary aeroplane. In order to take off, the necessary revolutions of the rotor blades must be obtained, and the brakes then released. The machine immediately begins to taxi in a normal manner, but takes off suddenly at a comparatively low horizontal speed, maintaining a fairly rapid climb at a slower forward speed than the conventional type of aeroplane. When the pilot wishes to make a turn the rudder only need be used, as the machine banks automatically

In a normal landing when the engine is throttled down the Autogiro glides at any speed desired until a height of from 3 feet to 10 feet above the ground is reached, and then the 'stick' is pulled hard back. The nose rises, and the machine stops at once, dropping very slowly to settle on the ground. If a forced descent from engine-failure or any other cause necessitates a landing in a small field surrounded by high trees or similar obstructions the machine can be made to drop slowly and vertically, but with perfect stability and still completely under control.

It seems probable that the Autogiro is the machine of the future. Its safety and ease of operation will make flying possible for many people who are unable to develop the necessary skill to pilot an ordinary aeroplane A beginner is able to take complete charge of an Autogiro after only a short period of dual tuition, for there is no danger of his getting into difficulties owing to the loss of flying speed, and there is no need for the delicate handling that is essential in a normal aeroplane. The short space necessary for the Autogiro to take off is another feature of great value, for it means that the machine may be operated from a space no bigger than a good-sized lawn.

Discussions have taken place recently between the Cierva Autogiro Company and the British railway authorities with regard to the possibility of constructing flat roofs over railway stations from which Autogiros could operate Nothing definite has yet been decided, but the scheme is full of interest, for it would enable travellers to make journeys between cities and their air-ports much more quickly than is at present possible.

CHAPTER XVIII

AIR TRANSPORT TO-DAY

THE first air service, from Hendon to Paris, was organized by the Royal Air Force. The machines, which were R.A.F aircraft, were used to transport officials to and from the Peace Conference, and the service operated intermittently as and when required. Next followed the Folkestone-to-Cologne service, which transported mails (or, rather, official correspondence) between London and the Headquarters established on the Rhine. On August 25, 1919, the first regular commercial service was commenced by the Aircraft Transport and Travel, Ltd., with a daily service in both directions between London and Paris. Immediately afterwards a service to Brussels, as well as to Paris, was started by Handley-Page Transport, Ltd., who had previously made test flights between London and the Continent. In November 1919 the Post Office entered into a formal contract to employ the London-Paris aeroplanes for the transport of mails. The fee first charged for the aerial carriage of a letter between London and Paris was half a crown. In the spring of 1920 the Handley-Page Company, in conjunction with the Royal Dutch Air Service (known as the K.L.M.) organization, commenced to operate regularly on the London-Amsterdam route. About the same time two other companies, S. Instone and Co., Ltd.,[1] and the Airpost of Banks, started services between London and Paris. Early traffic returns did not justify a continuance of some services, and at the end of the summer season of 1920 the Handley-Page Company shut down their Amsterdam and Brussels lines.

[1] Their first aeroplane was acquired for the transport of urgent documents between their London office and the Continent.

A governing control of the Aircraft Manufacturing Company, whose subsidiary concern, Air Travel and Transport, was operating the London-Paris route, was acquired at about this time by the B S.A. and Daimler groups. After investigation they decided to continue the air services, and during the summer season of 1920 the routes between London and Paris and London and Amsterdam were conducted with encouraging results. The London-Paris fare had been reduced from its original twenty guineas to fifteen guineas and then to ten guineas, at which figure it had been stabilized for some time. In February 1921, however, the French, who had the assistance of considerable State subsidies, announced a sudden 'cut' to six guineas. This Government-aided competition made it impossible for the British companies—which had not at that time any State assistance—to carry on their services. For a period of nineteen days no British aeroplanes flew between London and Paris, although the pilots had offered very sportingly to fly without pay until things took a more favourable turn. Then the first subsidy scheme was put into operation, the arrangement being that the Handley-Page Company and Instone and Co. flew on alternate days. The B.S.A. and Daimler combine had decided to stop altogether the A.T. and T service, and the de Havilland machines of this organization were acquired by Instone and Co, whose own private airmail had expanded into a service for passengers for some time prior to this. The temporary subsidy scheme continued until September 1921, when it was amplified, the Handley-Page and Instone Companies both flying daily between London and Paris. Tenders were invited for a further official scheme, and the B.S A. and Daimler combine reappeared on the scene in the form of the Daimler Airway There were now three subsidized British companies on the London-Continental routes—Handley-Page Transport, Instone and Co., and the Daimler Airway.

In October 1922 there was an important division of routes Daimlers were allocated the London-Manchester and London-Amsterdam routes, the latter with a link to Berlin in conjunc-

tion with the German Aero-Lloyd Company; the Handley-Page Company were to operate the London-Paris line, and Instone and Co. to concentrate on London-Brussels-Cologne In August 1923 the Handley-Page Company started an experimental service to Basle and Zurich, and Instone and Co negotiated to fly through from Cologne to Prague, but were prevented by complications arising through Allied restrictions upon German aviation. In March 1924 came the big landmark in British commercial aviation—the merging of all the British air-lines into the one State-aided enterprise. In addition to the Handley-Page Company, the Instone Air Line, and the Daimler Company, a fourth organization, the British Marine Air Navigation Company (which was operating a flying-boat route between Southampton and the Channel Islands and which had carried out a number of pioneer flights), was absorbed in this amalgamation, the Imperial Airways, Ltd , to whose activities we shall refer later.

In the meantime long-distance flights had opened up possibilities on other routes and had established greater confidence in the aeroplane as a means of transport.

All these achievements were of the greatest service in testing the reliability of engines for long-distance flights, and the ability of aircraft to withstand all kinds of weather What is of even greater importance is that the flights laid the foundations of the air-transport services of the future.

In commercial air transport there are three main requirements—reliability, regular running, and safety. Whether or not these requirements are forthcoming depends largely on the ground organization of the service. Because of this it has been said that the success of commercial air transport does not lie so much in the air as on the ground. Ground organization not only includes aerodromes and landing-grounds—with their hangars, workshops, and stores—but also beacons, fog-signals, and other guiding or warning devices, and the all-important wireless and meteorological services.

Before an air-route can be successfully established considera-

tion must be given to the amount of available traffic that it would be possible to carry by air In considering these factors it must be remembered also that it may be possible to create new traffic by virtue of the fact that much time can be saved as compared with existing means of transport. Among the disadvantages are the possibilities of adverse meteorological conditions that may exist over the route to be operated, and the length of the compulsory non-stop stages to be flown The cost of operating a route depends on the cost of labour and fuel, the type and the number of machines employed, the frequency of the service required, and whether it is to be run by day or by night, or as a combination of both.

The aerodrome that serves the capital city of a country is called the terminal aerodrome, and its location is important, for naturally it should be as near as possible to the centre of the city it serves. In the case of England, the terminal aerodrome is situated at Croydon,[1] but its situation is not ideal—it is thirteen miles from the centre of London, and the roads of communication are not good. On the other hand, Berlin has a well-situated terminal aerodrome (it is less than ten minutes' car-ride from the centre of the city), where advantage has been taken of a large open space that before and during the War was used as a military parade-ground. At the terminal aerodrome air traffic is controlled by the Civil Aviation Traffic Officer, who has a clear view of the landing-ground from the control tower. He and his staff receive and dispatch all messages from and to aircraft in flight, record or calculate the positions of all aircraft, and send out instructions as to the courses and information about weather conditions The control officer gives aircraft permission to leave or land, and his office is virtually the nerve-centre of all air traffic within the area in which it is situated

[1] Until the summer of 1920 the air-port for traffic between London and the Continent was at Hounslow. It was transferred to Croydon because the latter was on the side of London nearest the Continent and was outside the London fog-zone.

Practically all communications with aircraft are made and received by wireless—the exceptions being visual signals or dropped messages. Wireless communication between the ground and aeroplanes is by telephony on a wave-length of 900 metres Wireless not only enables a pilot to communicate with the ground so that he can obtain useful information—such as weather reports from areas into which he may be flying—but it also enables him to obtain his bearings if lost. In England there are special wireless stations at Croydon, at Lympne, and at Pulham, in Norfolk; in France at Le Bourget (Paris), at Abbéville, and at Saint-Inglevert, near Calais; in Belgium at Haren (Brussels), Ostend, and Uccle; in Holland at Rotterdam and De Bilt In order to obtain better operation of air transport within an area bordered by London, Paris, Cologne, and Amsterdam, the wireless services of Great Britain, France, Belgium, and Holland have been co-ordinated. When on the English side of the Channel aircraft flying eastward communicate with British stations, and remain in touch with them until they cross the French or Belgian coast. Correspondingly, the stations on the Continent are in touch with westward-flying aircraft as far as the English coast Should a pilot be lost or doubtful as to his position, he obtains his bearings by calling up the control-station, where the direction of his signal is taken At the same time the control-station asks (by telephone) two other direction-finding stations also to take the pilot's bearings, and in a few seconds these are transmitted to the control-station. The three bearings [1] are then plotted on a chart, and the point of intersection of the two gives the position of the signalling aircraft, which information is quickly transmitted to the pilot.

Aircraft are navigated by compass, exactly as ships are navigated. Air navigation is somewhat simpler, however, because, as much flying is done over land, the map can be used and landmarks picked up to check positions in a way that is not possible at sea. The two essentials of air navigation are

[1] In England the three bearings are taken at Croydon, Pulham, and Lympne

maintaining direction and fixing position. In some cases the first can be done by following some prominent feature such as a river, road, or railway. Position may be fixed by noting some landmark on the map, which is necessary in any case, even when flying by compass, as otherwise the direction of flight cannot be ascertained. Flying by map is not practicable on all occasions, however, and often visibility is reduced to a range of only a few hundred yards because of clouds or ground mists

On many routes flying is now assisted by beacons or aerial lighthouses. For example, on the 220 miles of the London-Paris route there are six aerial lights on the English side of the Channel, and seven on the French side. In addition to these, four French lighthouses have been modified for use as aviation lights Aerodromes are equipped with some form of lighthouse or beacon with a characteristic flash so that the pilot can identify it. At Croydon there is a location light consisting of a fog-penetrating red neon light, which flashes at regular intervals. At Mont Afrique, near Dijon, a white flashing light was installed to assist the return of bombing machines from Germany. This light, which is now used as an aerial light, is of 1,000,000,000 candle-power, and is visible at a distance of several hundred kilometres In the United States practically 2000 miles of airway from New York to Rock Springs, *via* Chicago, have been lighted. The main aerodromes have floodlights, the boundaries being marked by flashing red lights. The direction of the wind is indicated by red lights that are flush with the aerodrome surface. On each of the main aerodromes there is a 36-inch Sperry arc revolving beacon of 500,000,000 candle-power, visible at a distance of over 150 miles. Emergency landing-grounds twenty-five miles apart are illuminated by 5,000,000 candle-power incandescent beacons, visible at forty miles' distance. At intervals of three miles are small 5000 candle-power beacons visible at a distance of seven miles.

The great enemy of the air-pilot is fog, which obliterates all landmarks and ordinary landing-lights. Illuminated tubes

filled with neon gas are used to mitigate the dangers of fog as far as possible, for the neon light has remarkable fog-penetrating qualities At Croydon there is a beacon consisting of sixteen 20-feet neon tubes, arranged to give a pillar of light So effectively does the neon light penetrate fog that the Croydon beacon has been seen by an observer at a distance of nearly three miles through an intervening bank of fog 300 feet in depth. Another method of facilitating landing in fog consists of radiating strong electrical impulses from cables laid along the ground across the aerodrome. These electrical impulses are picked up by suitable apparatus on the aeroplane, and as long as the machine remains within the influence of these impulses the pilot is assured of a safe landing.

At every aerodrome there are indicators to show the direction of the wind. These indicators generally consist of a pivoted arrow, painted white and illuminated at night, which revolves according to the direction of the wind. Sometimes the indicator is a tapered canvas or linen tube, or 'stocking,' as it is called, mounted on a ring so that it will always be open The bag is suspended from the ring by a triangle of cord, the apex of which is fixed to the top of a mast. Thus the wind, blowing down the stocking, keeps it extended, and the mouth is always into the wind At Croydon this arrangement has been superseded by a new type of wind-indicator, visible both day and night The new indicator is a large letter 'T' some 20 feet long, with a head 10 feet in length, mounted on ball bearings on the top of a tower 20 feet above ground-level At night the head of the 'T' is outlined by a row of neon tubes, which glow a brilliant red when current is passed through them In some aerodromes electric lights covered with thick plate-glass are sunk flush with the ground and arranged in the form of a letter 'L' Different electric circuits can be connected, illuminating the letter 'L' so that the long arm is parallel with the direction of the wind, the short arm being arranged at the end from which the wind is blowing. The same system is also employed when flares are used instead of

electric lights, the flares being placed in position by hand when required.

Landing at night is assisted by ground illumination, for which searchlights of high power generally are used, care being taken to control the beams so that the pilot is not dazzled The boundaries of landing areas are marked with red flashing lights mounted on white pillars, which are distinctive by daytime and illuminated at night Buildings, wireless masts, and other obstructions are marked by red lights

The meteorological service is of the greatest importance to successful working of any route. Not only does the service forecast weather conditions, so that the pilot may be informed as to the conditions he must expect on the flight he is about to make, but conditions are observed and data are tabulated so that advice may be given on the planning of new air-routes The success of forecasting depends largely on the efficiency of the wireless service, and on the accuracy of reports received from observers at distant stations Not only does the Air Ministry maintain meteorological stations at Croydon and Lympne, and at several R A F aerodromes, but there are also many reporting stations at different places in the British Isles, and much valuable information is obtained from ships at sea Meteorological conditions play an important part in air transport. For example, the changeability in the climate of Western Europe results in a very complex organization of the cross-Channel routes, whereas the greater stability of meteorological conditions in the East make much easier the organization on such a route as that from Cairo to Karachi, even though the distance covered is over ten times as great as in the case of the cross-Channel route.

The main air-routes across Europe are governed by the location of the mountain-ranges, the greatest of which is, of course, the Alps. Not only are mountains the cause of disconcerting air-currents and pockets, but they increase the difficulties of flying in that they necessitate the machines riding at a greater height than otherwise would be the case. Fortun-

ately, most of the cities of Europe lie north of the Alps, so that the most important air-routes run east and west, with subsidiary routes running north and south.

The London-Paris route extends to Basle and Zurich, with connections at Basle to Barcelona, Berne, Lausanne, Geneva, and elsewhere.

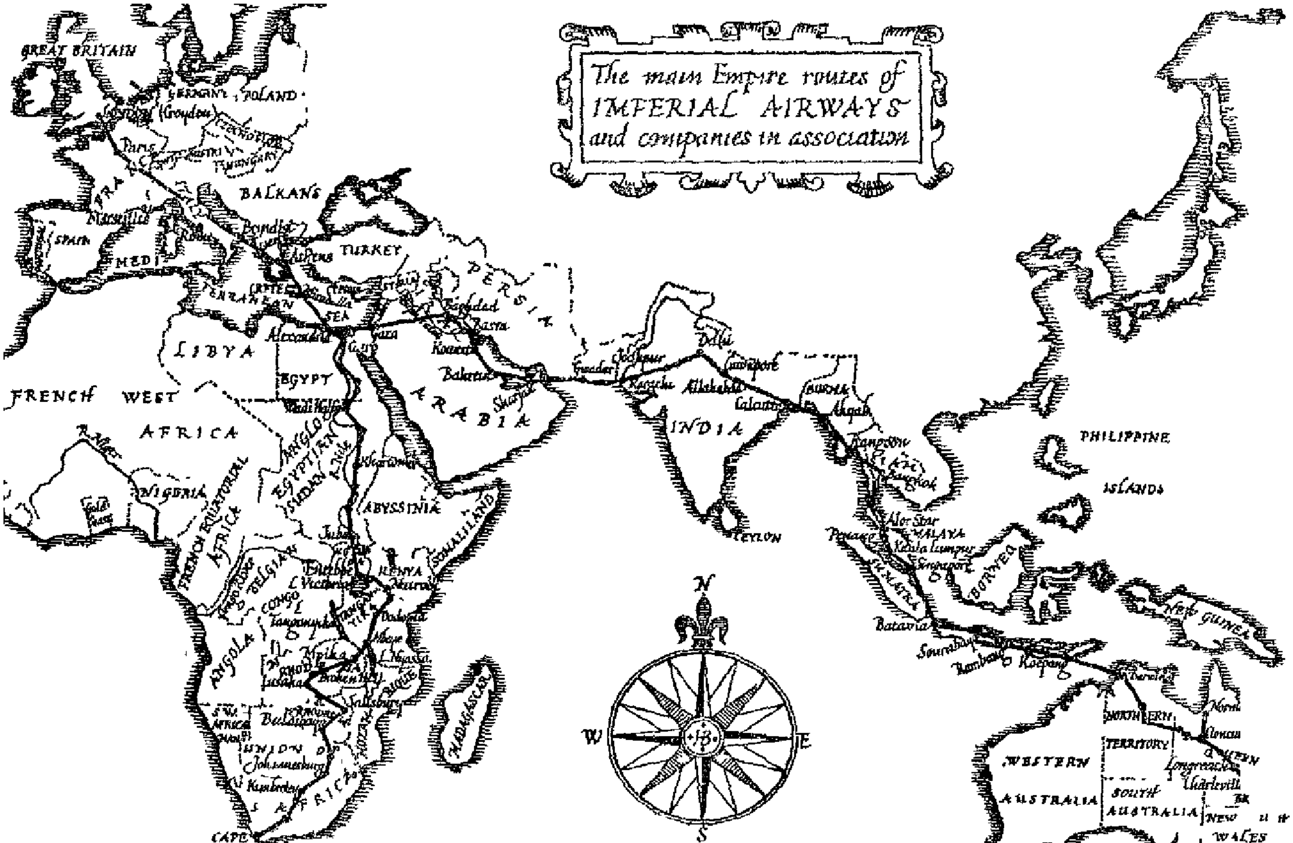
On the London-Brussels and Cologne route there are connections to Ostend, Antwerp, Dusseldorf, Essen, Hamburg, Leipzig, Breslau, Cassel, Dresden, Berlin, Copenhagen, Geneva, Moscow, Riga, etc.

The London-Amsterdam route is operated by the Deutsche Luft Hansa A G. (German) and the Royal Dutch Air Service (the K.L.M.). The service between Paris and Amsterdam is operated by the K L.M. and the Farman Air Lines of France The passenger is taken forward from Amsterdam to Berlin by the Deutsche Luft Hansa, which also works forward to Moscow—at present the eastern limit. From Amsterdam a route extends to Denmark, Norway, and Sweden, terminating at Malmo. It is operated by the A.B. Air Transport of Sweden, in conjunction with the Deutsche Luft Hansa A G. Berlin is the centre of many important routes covering Eastern Germany and Poland, with an extension to Prague and Vienna, and connections through Danzig and Riga to Leningrad and Finland.

The Empire route to the East from London is by way of Paris, Brindisi, Athens, Alexandria, and then on to India by way of Cairo, Gaza, Rutbah Wells, Baghdad, Basra, Koweit, Bahrein, Sharjah, Gwadar, Karachi, Jodhpur, Delhi, Cawnpore, Allahabad, and Calcutta. From there the route passes through Akyab, Rangoon, Bangkok, Penang, Kuala Lumpur, to Singapore, with an extension by way of Sumatra and Java to Australia. On this route Egypt is reached in two days seven hours, and India in five days two hours thirty-five minutes

In 1931 an extension was opened through Africa by way of Khartoum to Kisumu and Mwanza

Passenger air transport nowadays is a comparatively simple



The India-Australia Route between KARACHI and SINGAPORE is operated by Imperial Airways

matter—even more so than travelling by train or boat. A passenger wishing to travel from London to Paris books his passage at any travel agency or direct from Imperial Airways He may leave Croydon at 8 A.M. and be in Paris in time for morning coffee, or may leave at midday and be in Paris by about 3 P.M. London passengers assemble at Airways House, Charles Street, S.W.1, where their baggage is weighed (each passenger is allowed to carry 15 kilograms of luggage free, excess being charged at sixpence per kilogram) They are then conveyed by car to Croydon, and, their passports having been examined, they take their seats in the aeroplane, luggage being stowed away in a special luggage compartment. The door of the cabin having been secured, the passengers are soon *en route* for Paris. On the arrival of the machine at Le Bourget (Paris) the necessary formalities are carried out in the reverse order, and the passengers are taken in a car to Airways House, 38 Avenue de l'Opéra Hotels are used as the rendezvous for passengers by many of the other Continental companies

The transport of freight is equally simple, and normally there is no reason why goods from London should not be delivered in Paris within a day, and *vice versa*. Several times each day goods are collected from the city by an agent of the air companies and are conveyed to Croydon, where they are passed through the customs and taken on board the waiting machines for European destinations. Usually the older twin-engined machines are reserved for freight transport, leaving the more modern three-engined types for passenger traffic Arriving at their destination, the goods are passed through the customs and sent out on delivery vans for distribution. In cases of urgency special clearance arrangements are made for important parcels, which can be away from Croydon, for instance, five minutes after the arrival of the aeroplane that has brought them from the Continent. On the England-India route of Imperial Airways goods now reach Egypt from London, by the accelerated service, in not more than three days, and are in India in only an hour or so over five

days, while urgent loads are air-borne from London to the heart of Central Africa in just over six days.

Air transport is particularly advantageous for carrying fragile articles, for much less handling is involved than with any other form of transport. Valuables are carried by air owing to the decreased risk of pilferage. Bullion in very large quantities has been carried by the Imperial Airways, as well as other precious metals, stones and jewellery, paper money, securities, dresses and furs to a considerable value. Air transport is also largely used for the transport of live-stock, and of many other commodities ranging from motor-bicycles to perfume. It is of the greatest service, too, for the transport of mails, which constitute the best paying class of air traffic. Letters intended for this form of transport may be posted at any post-office, a special fee being paid, and on the envelope is affixed an air-mail label marked "By Air Mail" Special pillar-boxes, painted blue, are now being provided for the posting of air-mail letters The mail is taken to Croydon in time for the departure of each machine, and incoming machines are met for the collection of inward mails, which are delivered by the first ordinary postal delivery, unless an express delivery fee has been paid.

The growth of commercial air transport is one of the most remarkable of all post-War developments, and some idea of the progress that has been made may be gained from the following figures In 1919, when civil aviation began, there were about 3000 miles of organized aeroplane routes throughout Europe. To-day, according to the latest figures (which include the air-lines operated by Russia), the total stands at over 58,500 miles.[1] The air-route mileage of the world has grown steadily year by year, until it now totals over 200,000 miles, and it is estimated that approximately 540 towns and cities are served by aerial routes.

[1] This figure is taken from the 1929 *Report on the Progress of Civil Aviation* Unfortunately no later figure can be given, for subsequently to the issue of that report the calculation of European route mileage has been discontinued in favour of the world-route mileage figure The figure of 58,500 included sections of certain routes that, although starting from Europe, terminated outside the European boundaries

From the date of the constitution of the Imperial Airways (April 1, 1924) to March 31, 1931, the miles flown on the European, England-to-India, and England-to-Africa services amounted to 7,010,577; the number of passengers carried, 170,159; freight carried, 6139 tons; the total route mileage (including the extension to Delhi and Africa), 11,453.

It should be mentioned in passing that in Britain a Government subsidy was considered necessary to support commercial air transport through its initial stages. The subsidy commenced in 1921, and since that time there have been five different systems in force. In each of the following subsidy schemes a maximum possible payment was indicated, it being agreed that this amount of subsidy should not be exceeded in any one year. The original subsidy was paid on a basis of running costs plus 10 per cent. on takings, for a number of flights determined by a minimum and a maximum on the London-Paris route. A later scheme was based on a payment of £3 per passenger and 3*d* per pound on goods carried, with an additional payment dependent either on a mileage or a flight basis. A fourth scheme provided for payment purely on a mileage basis. The present scheme is based on a payment for horse-power mileage, it being a necessary qualification that a minimum number of horse-power miles shall be flown before the full subsidy can be claimed. The horse-power mileage in this case remains constant, but the subsidy is periodically decreased.

Aeroplanes can be used successfully for the quick transport of wounded in campaigns in which operations are conducted at a considerable distance from a hospital base. During the War, for instance, the aeroplane ambulance was of great value in Mesopotamia, where there are practically no roads and where the nearest hospital—apart from field stations—was often a hundred miles or more in the rear One type of machine used for this work was the Vickers 'Vimy' Ambulance, fitted with 450 h.p. Napier 'Lion' engines (Plate XXX, *C*). These ambulances had accommodation for a doctor,

nurse, four stretcher cases (or eight sitting-up cases), and a crew of two. When not in use for hospital purposes the machines could be used for troop-carrying With these aeroplane ambulances the sick and wounded were rapidly evacuated in the campaign in Iraq, where the only other available transport was by means of pack-animals.

The first occasion on which these ambulances were employed on a large scale was in April 1923, when there were 200 cases of dysentery in a column of British troops operating in Northern Kurdistan. Several aeroplanes were dispatched from Baghdad to Kurkuk on April 28, the landing-place being selected at a point near Serkhuma, and the evacuation was successfully concluded on May 2 During the first two days bad weather was experienced, and the pilots were called upon to exercise more than ordinary skill. It was necessary to climb to at least 5000 feet when crossing the Adghiar Dagh Mountains, where the air-currents were so strong that on one occasion an ambulance with patients on board was forced down from 3800 feet and crashed in inaccessible country Fortunately, none of the sick was injured—indeed, it is stated that one of the patients actually had to be awakened and told to get out of the damaged machine! Its location was such that it was impossible for other aeroplanes to land to pick up the patients, but a smaller aeroplane with a medical officer on board managed to land close to the crashed ambulance, and took off one of the patients who was dangerously ill. The remainder of the patients successfully accomplished the long and difficult journey from the scene of the accident to Koi on donkeys and ponies, with the medical officer in attendance.

On the occasion in question 198 cases were evacuated to Kurkuk and conveyed to Baghdad, the transport being completed in 128 hours 45 minutes actual flying time, the aeroplanes having covered 9615 miles All the patients stood the journey well, the majority seeming to enjoy the experience of being transported by air ambulance During the following

two months over 160 patients were brought into Baghdad by air ambulance from outlying stations

Among many other instances that could be mentioned of the commercial utility of the airway, none could be more conclusive than that of a party of motorists in Africa Not far from the Juba station of the Imperial Airways African route they had a breakdown with their car, and could not continue their journey unless they could obtain a spare part from England They cabled immediately to the manufacturers in this country, and in less than fifteen hours the part required was rushed up to London and on to the out-going African air-mail from Croydon. The result was one that amazed these marooned travellers, and afforded a striking illustration, which they say they will never forget, of what modern high-speed transport can accomplish. Although the party was 5000 miles from London, and in a remote locality where, had it not been for the air-mail, they must have waited weary weeks for what they wanted, actually in not more than seven days from the dispatch of their cable to England the essential part they needed was handed to them at the Juba air-station by an official of Imperial Airways. One of the members of the party wrote: "It revolutionizes one's ideas of time and distance to be able to procure a vital spare part thousands of miles from England, and to receive this in the heart of Africa only a week after the telegraphed request was made" Motor-car manufacturers are using the air-service on a rapidly increasing scale whenever the time factor is important. Often motorists on the Continent will cable to London for some spare part for their cars, and this goes to them immediately in the next air express, frequently effecting a saving not merely of hours, but of days.